BOOK OF ABSTRACTS

TARRAGONA 26-29TH

5th European Biosensor Symposium

SPEAKERS LECTURE

PROF. DR. PAUL YAGER

Abstract for EBS 2025

Pushing the boundaries of paper microfluidics for improving and maintaining health

For a few decades, our laboratory has been pursuing the development of low-cost diagnostic and health monitoring technologies for use in the developing world and homes using microfluidics. Since 2008 we have focused on using two-dimensional porous media ("paper") to minimize costs. We initially focused on detection of pathogens for infectious disease using isothermal amplification of DNA and RNA to simplify the supporting equipment needed. Lately, we have developed tests for respiratory pathogens (including the COVID-19 virus), urinary tract bacteria, and sexually-transmitted diseases including chlamydia, gonorrhea, and most recently, HIV at low concentrations to provide early warning of transmissibility. These all focused on sensitive detection above a threshold concentration. We are now focusing on quantitative measurement of proteins in biofluids, including blood, to enable proteomics and metabolomics for home use in monitoring chronic inflammation and related conditions.

PROF. DR. JOHN A. ROGERS

Interdisciplinary engineering research over the last decade has largely eliminated the mismatch between conventional, planar rigid electronic systems and the soft, curved surfaces of the human body. The resulting classes of soft, skin-interfaced wearable sensors are beginning to change the way that we approach patient care and health monitoring. This talk will briefly describe two on-going translation efforts in such technologies for monitoring vital signs of patients both hospital and home settings, and two newly published technologies associated with our research in this area. The latter includes sensors for (1) measuring molecular gaseous flux into and out of the surface of the skin and (2) continuous tracking of the volume of breast milk expressed during breastfeeding. In each case, I will highlight future opportunities for research in the engineering sciences.

PROF. DR. CAN DINCER

Disposable sensors are low-cost, easy-to-use devices designed for short-term or single-use measurements. Over the past decade, they have gained increasing importance across various fields, including environmental monitoring, forensics, pharmaceuticals, agriculture, food safety, and especially diagnostics—most notably in point-of-care testing and wearable technologies. This talk will begin with a brief overview of disposable sensor technologies, followed by a presentation of diverse biosensing approaches enabling next-generation on-site testing: (i) multiplexed on-site therapeutic drug monitoring of antibiotics from invasive and non-invasive samples toward personalized antibiotherapy; (ii) CRISPR-powered electrochemical biosensors for amplification-free, simultaneous detection of multiple RNAs and biomolecules for infectious disease management; (iii) wearable microfluidic immunosensing platforms for lab-on-a-bird applications and beyond; (iv) low-cost electrochemical paper-based wearable sensors that can be integrated into various facemasks for continuous breath monitoring and infectious disease screening; and (v) light-controlled dynamic bioassays (OptoAssays) utilizing optogenetic switches for wash- and pump-free point-of-care diagnostics. Together, these developments highlight the transformative potential of disposable sensors in advancing accessible, rapid, and decentralized testing solutions.

DR. SUSANA CAMPUZANO

Frontier Bioelectroanalytical Technologies: Shaping the Future of Precision Health for All

Susana Campuzano[1,2], Rebeca M. Torrente Rodríguez[1], Víctor Ruiz-Valdepeñas Montiel[1], Eloy Povedano[1], Maria Gamella[1], Verónica Serafín[1], Sara Santiago[1], Ana Montero-Calle[2], María Pedrero[1], Rodrigo Barderas[2,3], José M. Pingarrón[1]

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Today, we continue to witness the potential of advanced, reliable, and multifunctional (bio)electroanalytical technologies to drive cutting-edge research and personalized healthcare, as well as their promising foray into previously unexplored areas, progressively securing societal confidence to advance steadily toward sustainable and efficient healthcare systems [1].

These "giant steps" have been driven by strategic collaborations. Among the most notable are the identification and application of bioinspired receptors developed through state-of-the-art approaches—such as phage display for peptide selection, alternative splicing for generating proteoforms, site-directed mutagenesis for engineering protein ectodomains, and recombinant expression of complete proteins in mammalian cells [2].

At the same time, intensive efforts have focused on designing and functionalizing (nano)materials with electrocatalytic, pseudoenzymatic, antifouling, or biomolecule-anchoring properties. Such materials have been applied as nanolabels to enhance electrochemical signals and as electrode surface modifiers, markedly improving bioelectrochemical sensitivity and robustness [3–5].

Within a dynamic and rapidly evolving landscape, the Electroanalysis and Electrochemical (Bio)sensors Group at the Complutense University of Madrid and its collaborators are currently conducting cutting-edge research. This keynote summarizes their key achievements of 2025, showcasing the development of novel, adaptable, robust, multiplexed, multi-omics, user-friendly, and cost-effective (bio)electroanalytical platforms, as well as their integration with complementary fields, such as proteomics [6] and bioinformatics. These technologies have revealed clinically relevant biomarkers and molecular signatures across omics—including previously unstudied [7] or overlooked [8] targets—and enabled their accurate, multiplexed detection in real-world settings, opening unique opportunities for advancing personalized medicine for all.

Acknowledgments: Grant PID2022-136351OB-I00 funded by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe".

DR. SUSANA CAMPUZANO

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PROF. DR. EUGENIO MARTINELLI

Abstract

The importance of organ-on-chip (OoC) technologies has become increasingly evident in recent years, driven by advances in microsystem engineering and the use of induced pluripotent stem cells (iPSCs) for the development of biological models. These advances have enabled the creation of innovative and more accurate experimental platforms that better reproduce human physiology compared to traditional approaches. Moreover, the integration of time-lapse microscopy and embedded sensors now allows data acquisition with unprecedented spatial and temporal resolution. To fully exploit and interpret this wealth of information, tailored data analysis strategies are required, depending on the specific OoC platform. In this talk, we emphasize the role of machine and deep learning in OoC studies, highlighting how these approaches can provide deep insights into complex biological processes and support the development of personalized therapies.

PROF. DR. ROMAIN QUIDANT

Revisiting biosensing with digital holography and hyperspectral imaging

Romain Quidant

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In this talk, we present how well-established microscopy techniques like digital holography and hyperspectral imaging, when combined with microfluidic and surface chemistry, can address some of the key challenges in biosensing.

The first technique we present aims to tackle label-free, high-throughput detection of multiple analytes in heterogenous samples. We introduce an optofluidic platform that integrates state-of-the-art digital holography with PDMS microfluidics, utilizing supported lipid bilayers as a versatile surface chemistry building block. This platform enables the label-free, single-particle-sensitive fingerprinting of heterogeneous extracellular vesicle populations through a multiplexed immunoaffinity assay [1,2]. We demonstrate the potential of this approach to extend beyond extracellular vesicles to single proteins. Beyond simple detection, digital holography can also provide additional insights into biomolecular properties. By employing polarization-sensitive off-axis holography, our system enables single-shot retrieval of circular dichroism (CD) and optical rotatory dispersion (ORD) images [3]. This approach not only aligns with traditional CD spectroscopy but also offers the unique capability to spatially resolve local chirality variations that are often obscured by ensemble averaging.

The second part of the talk introduces a novel high-throughput, droplet-based platform that enables multiparametric kinetic analysis of aptamer-target interactions in minute volumes. By integrating picoliter-volume droplets with Förster resonance energy transfer (FRET)-based detection and automated imaging, our approach allows for real-time monitoring of aptamer binding and structural switching with unprecedented spatiotemporal resolution and minimal reagent consumption. Our approach provides detailed insights into binding kinetics and conformational dynamics, overcoming the limitations of endpoint or low-resolution techniques. To demonstrate the platform applicability, we interrogated the influence of the stem loop length on the switching behaviour of a serotonin structure-switching aptamer. Remarkably, we demonstrate direct measurements in complex biological media, such as serum, offering a more accurate reflection of real-world biosensor deployment scenarios [4]. Our findings provide a significant step forward in the rational design and optimization of aptamer-based systems and open new avenues for tailoring molecular recognition elements for a wide range of nanotechnological applications.

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DR. MAY MORRIS

ABSTRACT European Biosensor Symposium Oct 2025
FLUORESCENT BIOSENSORS FOR DIAGNOSTICS & DRUG DISCOVERY

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One of the major healthcare challenges concerns early and personalized detection of relevant disease biomarkers, together with targeted therapeutics and companion assays to monitor therapeutic benefit. Protein kinases (PK) are central to most biological processes and signalling pathways, and are often dysregulated in human diseases thereby constituting relevant biomarkers and attractive pharmacological targets, with an arsenal of FDA-approved drugs available in the clinic (Fleuren et al. 2016; Cohen et al. 2021). Although genetic, transcriptomic and proteomic profiling approaches enable detection of these enzymatic biomarkers, they do not provide insight into their functional activity, thereby limiting our appreciation of PK dysregulation in physio-pathological settings. Moreover, most PK inhibitors target the ATP pocket and consequently suffer limitations associated with their lack of selectivity as well as emergence of resistance. Efforts to develop new classes of drugs targeting conformational transitions and non-catalytic functions of PKs are believed to offer promises for more selective therapeutics, but this remains challenging (Attwood et al. 2021).

In contrast, kinomic approaches, including fluorescent biosensors tailored to report on PK activities constitute potent chemical tools that can report on the functional behaviour of PKs in complex biological samples and further allow us to interrogate dynamic signalling pathways in their native environment in living cells (Morris M.C. 2022a, 2022b). To this aim, we have developed a toolbox of fluorescent peptide biosensors (FPBs) to monitor PKs involved in cell growth and proliferation that constitute notorious and relevant cancer biomarkers, but are currently underexploited for predictive diagnostics. These synthetic biosensors offer selective and sensitive means of quantifying differences in PK activities between healthy and cancer cells and report on alterations associated with targeted therapeutics (Morris M.C. 2022a, 2022b and references therein). We have further combined FPBs to profile several PK activities simultaneously and have implemented this multiplex approach to human biopsies derived from lymphoma, lung and pancreatic cancers, thereby highlighting distinctive PK signatures and yielding unique functional information, which complements genetic, biochemical and immunohistochemical analyses (Royet et al. 2024). Moreover, we have engineered hybrid biosensors for distinct and specific applications, including carbon nanotube-peptide nanobiosensors and FPB-microneedle arrays for transdermal applications (Tilmaciu et al. 2021; Howells et al. 2019). Moreover, fluorescent biosensors have been widely implemented throughout the drug discovery pipeline and constitute powerful tools to screen for new generations of drugs (Prével et al. 2014). We have engineered conformational biosensors that discriminate against ATP pocket binders, which we have successfully implemented to screen small molecule libraries. We have identified original allosteric modulators of PKs (Pellerano et al. 2017, Peyressatre et al. 2020, Laure et al. 2024), that we have characterized using complementary biochemical, biosensing and cell biology assays in vitro, in cellulo and in vivo, in chick embryo ex ovo models bearing tumour xenografts.

Taken together our studies underscore the potential of fluorescent biosensor technologies for establishing diagnostic assays and drug discovery programmes.

DR. MAY MORRIS

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DR. ENRIC MARCOS

Computational design of new-to-nature β-sheet proteins for next-generation biorecognition elements

The advent of de novo protein design is revolutionizing the field of protein engineering by enabling the creation of entirely new proteins with sequences and structures not constrained by nature. This approach offers tailored control over protein geometry, stability, and function, overcoming many limitations inherent in repurposing natural proteins. We have established design principles for constructing a wide range of hyperstable β-sheet–containing protein folds, ideal for hosting ligand-binding sites or supporting functional loops, such as those found in antibodies and nanobodies. Building on these insights, we leverage physics- and deep learning–based structure prediction and design methods to engineer novel immunoglobulin-like (Ig) scaffolds in both single- and two-domain formats with hyperstability and high structural accuracy; surpassing structural limitations of natural Ig frameworks. Ultimately, achieving structural control over Ig frameworks will open the door to a new generation of antibody-like proteins with improved properties and expanded functionalities useful for biomolecular recognition in biosensors.

DR. FIRAT GÜDER

Today in most geographies, hunger appears to be a problem solved and no longer an issue. This is, however, not the truth: According to the World Health Organization, in 2023, 733 million people faced hunger. In fact just a generation ago, even in the developed regions of the world, hunger was a frequent issue (feel free to ask some older family or friends). The modern food system consists of a complex network of processes which often starts in the laboratory with the screening or engineering of plants. Plants selected are bred and moved to the field for production which are susceptible to diseases and require nutritional supplementation through the soil to improve yields. Once harvested, products may include contaminants or harmful substances that require elimination. Eventually, food is distributed and consumed, however, because the current system of production and deployment is inefficient, much of it gets wasted (about 1/3) and is never consumed. This talk will focus on the application of sensing technologies throughout the food system and how these technologies can bring about improvements in production while reducing loss, a hugely important environmental and economic issue.

DR. ELENA BENITO-PEÑA

Lighting the Future of Biosensing with Next-Generation Luminescent Proteins

Bettina Glahn-Martínez,[1] Fernando Pradanas-González,[1] Riikka Peltomaa,[1] Álvaro Luque-Uría,[1] Marta García-Cortés,[1] Pablo Purohit, Fernando Navarro-Villoslada,[1] Guillermo Orellana,[2] María Cruz Moreno-Bondi,[1] Elena Benito-Peña[1]*

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Luminescent proteins (LPs) are a powerful bioanalytical tool with significant potential, increasingly adopted in next-generation biosensors due to their unique photophysical properties.[1] Unlike traditional fluorochromes, LPs are highly stable and genetically customizable, enabling their spectral features to be tailored to the specific needs of the analytical system. Additionally, their recombinant production allows for fusion with molecular recognition elements—such as mimotopes and recombinant antibody fragments—selected through genetic engineering techniques like phage display.

Based on this technology, our research team designs biosensor platforms where mimotopes, protein receptors, and recombinant antibody fragments are genetically fused with fluorescent proteins such as EmGFP,[2] YFP,[3] sfGFP,[4] or mScarlet-I.[5] These modular constructs enable highly sensitive detection of clinically and toxicologically relevant targets including immunophilin-drug complexes (tacrolimus, rapamycin)[6] and mycophenolic acid, as well as mycotoxins such as fumonisin B_1 or HT-2 toxin in samples spanning from whole blood and oral fluids to food matrices like wheat, oats, and vegetable oils. The developed systems show excellent analytical performance and are easy to operate, making them suitable for real-world analytical use.

To overcome external excitation and background fluorescence limitations in luminescent systems, we advanced bioluminescent platforms based on cutting-edge luciferases as optical reporters and tracers. Using *NanoLuc luciferase*[7,8] and *Gaussia luciferase*,[9] we have designed recombinant fusion proteins with mimotopes from phage libraries, enabling the implementation of homogeneous "mix-and-measure" assays that eliminate washing and chemical conjugation steps. These biosensors reach detection limits below ng/mL in clinical samples and food, producing highly intense signals with minimal background noise, thus enhancing their usability in actual applications.

In short, luminescent proteins are key to creating fast, accurate, portable, and ethical biosensing systems for point-of-care clinical diagnosis and global food safety assurance.

Acknowledgments:

This work has been funded by the Spanish Ministry of Science, Innovation and Universities (MSIU) (PID2021-127457OBC21/22).

DR. ELENA BENITO-PEÑA

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PROF. DR. JOSEP SAMITIER

“Odorant biosensors based on electrical properties of olfactory Receptors”

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Olfactory receptors (ORs) comprise the largest multigene family in the vertebrates, with about 400 genes identified in humans. They are expressed primarily by olfactory sensory neurons located in the olfactory epithelium in the nasal cavity and are responsible for odorant detection. The mechanism of olfactory transduction in the main olfactory epithelium involves Olfactory receptors switching from a conformationally inactive state towards an active state upon ligand binding, which couples with molecular mechanisms activation pathway in the neuron cell. Sensitivity values down to femtomolar concentrations for solubilized volatile organic compounds have been reported and down to ppb for gas analysis. However, the quantitative aspects of odorant detection remain largely unknown, thereby hampering odorant biosensors further development.

Combining different characterization techniques at molecular level such as electrochemical scanning tunneling microscopy and nanovesicles characterized by Surface Plasmon Resonance (SPR) measurements with macroscopical electrical characterization by potentiostat electrochemical impedance spectroscopy (PEIS) and cyclic voltammograms we have determined the nanoscale electrical properties of human OR in the presence of its cognate ligands.

These results pave the way towards the development of better biohybrid odorant sensors with application to detect volatile analytes and will allow validating OR structural-electrostatic models and their functional activation.

ABSTRACTS

APPLICATIONS

POSTER

5th European Biosensor Symposium

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Abstract Title:

A Modular Optical Interface for Real-Time Fluorescent Nitrate Biosensing Using Engineered Pseudomonas Putida

Abstract body:

Deploying whole-cell biosensors outside the lab requires hardware that ensures microbial containment and survival, analyte access, and reliable signal detection. The BioSensei - Horizon project addresses this by integrating engineered *Pseudomonas putida*—which fluoresces in response to nitrate—into a sealed chamber system. A key innovation is the chamber's stack design, allowing to load the cells after device fabrication. This increases the efficiency of the cells containment, and the ease of deployment. In addition it allows for a continuous flow of oxygen, nutrients, and analytes through a membrane and towards the cells. This contributes to the foundation of the Safe and Sustainable by Design (SSbD) framework of the project, while allowing for real-time environmental monitoring of pollutants in river water.

The system includes a chamber containing the cells, separated by a 0.2um pore size PET membrane, a transparent glass window for fluorescence detection and a flow-through design to allow for analyte and nutrients access. A reusable optical module featuring LED-based excitation (λ_peak = 470 nm), photodiode, and matching fluorescence filters, allows for real-time fluorescence signal detection. These signals are continuously transmitted to our Senseiver data platform for further analysis.

Initial validation of the chamber with rhamnose induced GFP in *E. coli*, showed sensitivity in the range of 1 to 5mM, a microbial response time of 2h and stability over the course of 48h. A similar bioengineering adaptation to *P. putida* strains was developed at Wageningen University & Research (WUR). The chamber enabled continuous monitoring of varying nitrate concentrations using *P. putida* engineered with a degradation tag in order to express GFP upon nitrate detection, and degrade it shortly after, which allows for a dynamic response. The flow-through design ensured consistent delivery of oxygen, glucose, and analytes, supporting cell viability. The robustness of the design safety is confirmed with qPCR on chamber waste.

Abstract References
https://www.biosensei.eu/the-project/

Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title:

A Novel Immunosensor for Saxitoxin and Tetrodotoxin: Towards Integrated Toxin Monitoring of Seafood

Abstract body:

The simultaneous presence of toxins such as tetrodotoxin (TTX) and saxitoxin (STX) in fish and shellfish poses a significant threat for food safety and public health due to their potent neurotoxic effects, which can lead to severe poisoning cases and fatalities. Traditional detection methods typically target a single toxin family, rendering them ineffective when several toxins are present simultaneously. In light of recent findings regarding the co-occurrence of TTX and STX in seafood, there is clearly a demand for advanced platforms able to detect several toxin families in a single analysis. In this work, a novel multiplexed electrochemical immunosensor for the dual detection of TTX and STX is proposed. The device includes an array of four electrodes: two test electrodes for detecting the presence of TTX and/or STX in seafood samples, and two control electrodes as reference thresholds according to the current regulatory safety limits for each toxin family. The combined information provided by the dual biosensor enables not only the identification of the specific toxins present in a sample but also an assessment of whether toxin levels exceed safety limits, offering a rapid, effective and easy-to-interpret screening method with potential to be applied in toxin monitoring. This dual-detection approach could pave the way towards integrated monitoring systems capable of identifying multiple marine toxins in a single test, thereby improving seafood safety and public health protection.

Abstract References

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Topics

Applications

Reverté, Jaume[1]; Turner, Andrew D.[2]; Klijnstra, Mirjam[3]; Gerssen, Arjen[3]; Mandalakis, Manolis[4]; Peristeraki, Panagiota[5]; Rambla-Alegre, Maria[1]; Diogène, Jorge[1]; Campàs, Mònica[1]

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Abstract Title:

A sensitive reversible nanoparticle assembly-based SERS platform for banana DNA detection

Abstract body:

Introduction

Low-concentration DNA detection ensures accurate identification of plant species in food products, enhancing traceability and compliance with regulatory standards. Prevalent methods like PCR are hindered by prolonged analysis, expensive, and false positives [1]. Sensitive and molecular-specific methods like surface-enhanced Raman spectroscopy (SERS) offers a superior alternative. SERS leverages molecule adsorption on rough metal surfaces, amplifying signals up to some trillionfold via plasmonic hotspots [2]. This study showcases a reversible plasmonic assembly of gold nanoparticles (AuNPs), facilitating multiple hotspots tuning for sensitive detection of banana flesh DNA. The method offers a robust alternative to traditional methods with enhanced efficiency.

Methods

A custom setup with a dove prism based Kretschmann configuration was employed to generate SPPs on gold thin film deposited glass coverslip at a gold-water interface [3]. A 785 nm diode laser was used as an excitation source. The synthesised AuNPs [4] were assembled in SPP field for SERS measurements.

Results

Upon introducing 100µL of AuNP solution on the gold film, AuNPs assembled at the excitation spot due to the combined effect of far-field fluid convection and near-field SPP forces (figure1(a)). Nanogap tuning is achieved by varying laser power; higher power reduces assembly size (data not shown). Optimal SERS enhancement occurred at 7mW coupled laser power [3]. For sensitive DNA detection, 10µL DNA (26mg/L) was added to a stabilized assembly, and SERS spectra were recorded. Figure 1(c) displays SERS spectra,

with peaks corresponding to specific molecular vibrations. The experiments are underway to determine the minimum DNA concentration detectable by our method.

Conclusion

Our system enables surfactant-free AuNP assembly for solution-based SERS measurements. We demonstrated the in-situ tuning of nanogaps by varying the incident laser power density. This approach successfully detected banana DNA, demonstrating its utility for biological sample analysis with low-power operation, offering a versatile method for sensitive molecular investigations.

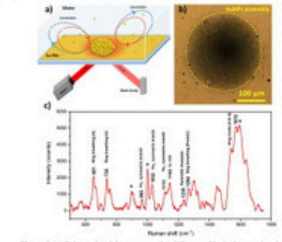

Figure 1: a) Schematic of the process of AuNP assembly, b) Image showing AuNP assembly on gold film, c) SERS spectrum of DNA extracted from banana flesh recorded at a coupling power of 7 mW.

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Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title: Accelerating Food Safety Decisions through Biosensor Technologies for Pathogen Monitoring

Abstract body: Foodborne illness remains a major public-health concern for the food industry. The World Health Organization estimates that roughly 600 million people worldwide become ill each year after consuming contaminated food, and approximately 420,000 of those cases are fatal. In Spain, a marked increase in reported cases and outbreaks linked to microbiological contaminants has been noted in recent years. This rise is attributed to several converging factors, including higher ambient temperatures driven by climate change, which foster microbial growth; global population expansion; intensification of agricultural and livestock production; and the spread of antimicrobial resistance. These circumstances highlight the urgent need to strengthen safety controls across the entire supply chain, from raw materials to consumer products, to ensure food safety and reinforce trust in the industry. Current microbiological surveillance relies largely on culture-based methods. While effective, these methods typically require more than 24 hours to deliver results and often demand additional confirmatory tests, further extending detection times. Such delays hinder rapid response during safety alerts and can have significant economic and public-health consequences. For this reason, rapid detection methods are attracting increasing attention in the food sector.

ECOSALIS and SENTINEL projects, leaded by ITENE, have led to the design of a fully automated device employing electrochemical biosensors for the selective detection of key foodborne pathogens, including *Escherichia coli spp.*, *Salmonella spp.*, and *Listeria monocytogenes*. Validation with diverse food matrices demonstrated the robustness of the system and its capacity to detect target microorganisms with limits below 100 CFU/mL, while significantly reducing analysis time compared with conventional culture-based methods. By enabling earlier and more reliable detection, this technology provides the food industry with a practical early-warning tool to support faster decision-making in contamination events. Its implementation could reduce the risk of pathogen proliferation and cross-contamination, limit the circulation of unsafe products, and mitigate the economic impact associated with product recalls and production disruptions. ECOSALIS and SENTINEL projects represents an advancement in microbiological surveillance, offering a pathway towards more proactive and preventive food safety strategies, and contributing to improved public health protection under increasingly complex environmental and industrial conditions.

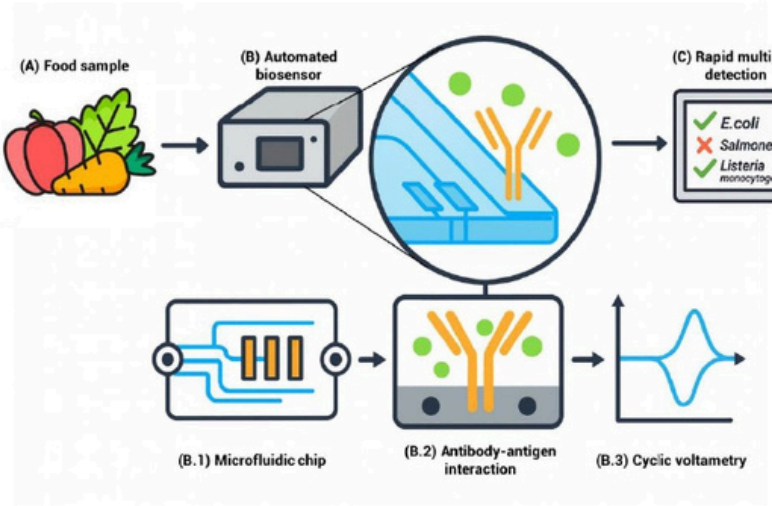

Figure 1. Schematic representation of the biosensing device and its components for microorganism control in food samples:

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Topics

Applications

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5th European Biosensor Symposium

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Abstract Title:

Automated multi-sensor array system for continuous on-site monitoring of groundwater quality

Abstract body:

In the 27 Member States of the European Union, groundwater provides approximately 65% of drinking water and 25% of the water used for agricultural irrigation. To ensure its continued safety and sustainability, key parameters such as heavy metals (e.g., copper, lead, cadmium), ions (e.g., nitrate, chloride), and toxins must be consistently monitored and maintained within regulatory limits. Traditional groundwater monitoring typically relies on periodic sampling and laboratory analysis, which can delay detection of contaminations and limit long-term, real-time assessment.

This study presents the development of a multi-sensor array system utilizing different ion-selective electrodes (ISEs) for continuous, on-site monitoring of essential groundwater quality indicators—specifically copper, nitrate, and chloride. A broad range of commercially available ISEs were evaluated based on criteria such as detection range, operational stability under varying pH and temperature conditions, cost-efficiency, and compatibility with an integrated sensor array setup. Literature from the past decade, including technical reports on industrial sensors, guided the electrode selection process.

Several technical challenges were identified in implementing an ISE-based multi-sensor system, including signal drift, interference from non-target ions, and the requirement for regular calibration. To address these, the project focuses on the automation of both monitoring and calibration processes, aiming to minimize manual intervention and enable long-term deployment in the field. Ongoing efforts include the integration of automated control algorithms and training data to support intelligent system behavior under changing environmental conditions.

The developed system holds significant potential for decentralized groundwater quality monitoring, offering real-time insights with reduced operational costs and timely interventions. Future work will involve system miniaturization, long-term field testing, and refinement of automated operation protocols to ensure reliable, maintenance-light performance.

Abstract References

Topics

Applications

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Benzimidazolium-Based Fluorescent and Colorimetric Probe for Selective Detection of Hydrogen Sulfide and Live-Cell Imaging

Abstract body:

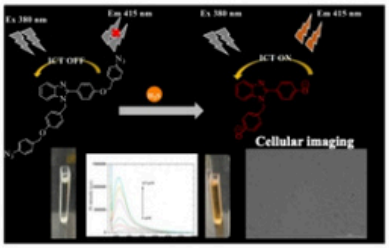
Background: H_2S, the third most abundant endogenous gas after NO and CO, plays a key role in regulating enzymes and cellular functions. It modifies proteins, engages in metal redox reactions, and influences multiple signaling pathways, making it a significant signaling molecule in cancer biology.

Methods: Designed a benzimidazolium based dipodal moiety, selected a benzimidazole scaffold as the fluorophore, and introduced the active cage unit 4-azidobenzyl bromide to create a typical D-π−A structure. By adding 4-azidobenzyl bromide, electron-donating function (D) and benzimidazolium, electron-accepting function (A), remarkable fluorescence properties were achieved.

Results: H_2S plays a vital role in several physiological and pathological processes as an endogenous gas transmitter. Considering the critical importance of this active biological molecule, it is therefore extremely valuable for clarifying the complex roles of H_2S to detect it. We have designed and synthesized a benzimidazolium based dipodal donor-acceptor type H_2S-selective probe. The probe exhibited a red shifted absorption peak at 530 nm and the fluorescence signal increased uniquely with the addition of H_2S. The synthesized probe shows their high selectivity and sensitivity towards H_2S. The mechanism of action of the probe showed the enhanced intramolecular charge transfer process upon the treatment with H_2S, accompanied by a noticeable color change. Owing to the low cytotoxicity and enhanced fluorescence emission, the probe has been further utilized for the imaging of endogenous and exogenous H_2S in living cells.

Conclusion: Developed a novel benzimidazolium-based dipodal probe with a 4-azidobenzyl bromide unit for highly selective H_2S detection. The probe exhibits a ~25-fold fluorescence increase at 410 nm upon H_2S

exposure, with nanomolar sensitivity. Its sensing relies on an intramolecular charge transfer mechanism and shows excellent biocompatibility and low cytotoxicity, allowing effective detection of H_2S in living cancer cells.



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Topics

Applications

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Biofunctionalization as Key Step in Biosensor Applications -- From R&D to Highthroughput Manufacturing

Abstract body:

Array based analytics have evolved into powerful tools for high-throughput multiplex analysis of a variety of classes of substrates as DNA, proteins, peptides, glycans, the detection of small molecule and screening of polymer properties. Further development of this technology focuses on new components and methods as surface functionalized substrates, probe deposition techniques, strategies of probe immobilization, target preparation and incubation as well as label and label free detection methods to improve sensitivity, reproducibility and to minimize material consumption. The transfer of these systems from open R&D platforms using e.g. microscopic slides to cartridge systems using fully integrated microfluidic chips or biosensors is another goal to enable fully automated diagnostics in the clinical laboratory and Point of Care applications.

A key step in the development of such systems is the biofunctionalization on the µm scale that consists of chemical functionalization of the supports to introduce reactive moieties, deposition of the probes and the subsequent immobilization reaction. All steps of this workflow widely depend on the design of the biosensors as the material and requirements related to the detection technology. Printing of probes on biosensors requires highly exactly spotting at predefined sensor elements based on optical detection of fiducials. The sensors are imbedded in microfluidic chips made of special polymer materials and of complex geometries. They can carry regions of different wettabilities and surface functionality designed for fluidic function, reagent storage and capture probe immobilization.

We will present recent results of biofunctionalization technologies including printing for reagent deposition on biosensors and immobilization technologies that allows immobilization of capture probes on the sensor elements. Application examples using biosensor and microfluidic chips will be presented.

Abstract References

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Topics

Applications

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Biomimetic Nanoplasmonic Sensor for Immunotherapy Evaluation

Abstract body:

In era of precision medicine, immunotherapies have emerged as a new hope to treat and cure serious diseases like cancer, viral infections, or autoimmune disorders. These therapies harness our own immune system to combat pathogens and malignancies with remarkable efficacy while minimizing adverse effects. However, complexity of current manufacturing and assessment protocols for immunotherapies development greatly hampers its global implementation, with unattainable costs and administration delays. To address this bottleneck, we aim at introducing innovative analytical technologies that allow rapid, accurate, and reliable study of cell interactions and immune mechanisms, thus accelerating and simplifying production and laboratory evaluation of these novel treatments. We developed a biomimetic optical technology based on nanoplasmonic sensing capable of monitoring cell interactions in real time and label-free format. Our biosensor exhibits excellent sensitivity and specificity, employing low-volume samples (150 mL) with relatively low concentration of cells (detection limits 102-103 cells/mL) and without external fluorescent tags (1-3). Through formation of artificial cell membrane, we can easily tailor type and number of receptors and ligands to be evaluated, minimizing time-consuming cell culturing procedures and offering nature-like platform for reliable cell biology studies. Furthermore, our nanobiotechnology system is integrated into a compact and user-friendly device providing rapid analysis (15 min/assay) at point-of-need. We demonstrated our methodology for the evaluation of monoclonal antibodies (mAbs) as immunotherapies for infections and cancer. In the first case, we introduced our technology for rapid screening of therapeutic antibodies as early anti-viral treatment for COVID-19, obtaining accurate neutralization data with low-moderate viral titers. In the second case, we employed our biomimetic nanosensor for analysis of immune checkpoint inhibitors (ICIs), particularly targeting programmed cell death 1 (PD1) pathway (4,5). The large versatility and unique

capabilities of our platform have the potential to support biomedical laboratories in the pursuit of efficient, accessible, and timely personalized medicine.

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Topics

Applications

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5th European Biosensor Symposium

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Abstract Title:

Conductivity measurements in milk with Screen-Printed Electrodes for the detection of bovine subclinical mastitis

Abstract body:

The electrical conductivity (EC) of a solution is a measure of its ability to carry an electric current and in milk, the conductivity is determined by the concentration of anions and cations. The most important ions in milk are Na+, K+, and Cl-. In mammals, the secretory cells of the mammary gland have active transport systems to pump Na+ and K+ so both ions are passively transported from the secretory cells into the milk [1]. Due to destruction of active ion pumping in mastitis-affected milk concentration of ions is altered so an increase in the EC of mastitis milk is obtained. Taking advantage of this, it is possible to detect bovine subclinical mastitis in infected cows by simply monitoring conductivity in milk [2].

Conductivity meters are devices commonly used for milk quality control that use standard conductivity probes which can be susceptible to contamination as they are reusable so a cleaning step after measuring is mandatory. Screen-printing technology offers the opportunity to develop disposable customized sensing devices so no further cleaning after measuring is required offering a better user experience.

In this work, novel disposable conductivity Screen-Printed Electrodes (SPEs), DRP-11COND, are evaluated with several milk samples. For comparison purposes, a classical conductivity probe with two cylindrical parallel electrodes connected to a mono channel conductometer is used.

Conductivity values obtained with SPEs have good accuracy and precision when compared to classical conductometer probes showing the ability of these new devices to obtain results comparable to standardized large non-disposable conductivity probes in milk quality control tests for the detection of bovine subclinical mastitis.

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Topics

Applications

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Development of a Prototype Biosensor for Determination and Monitoring of Myelin Damage

Abstract body:

Background. Myelin basic protein (MBP) makes up to 30% of myelin and it is known to be released into the cerebrospinal fluid (CSF) as a bioindicator of demyelination in multiple sclerosis [1]. In addition, in case of another demyelinating disease or trauma of CNS, MBP is present as a biomarker in human blood serum [2]. Herein, MBP specific aptamer earlier developed for possible therapeutic purposes [3] in mouse model was applied as a bioreceptor for both mouse and human MBP (mMBP and hMBP, respectively) recognition.

Materials & methods. A biosensor for MBP detection and monitoring was developed by using graphene oxide (GO) integrated onto the working electrodes with aptamer immobilized to create a bioactive layer on the sensor surface for MBP binding. The measurements were carried out using electrochemical impedance spectroscopy (EIS).

Results. The biosensing system designed was optimized and adjusted for application both in CSF and blood serum. In CSF LOD was 0.65 ng/mL and in the blood serum 0.35 ng/mL correspondingly. Using carbon-based nanomaterial with large surface area aggregated with aptamer showed high specificity and affinity to the target molecule and enabled selective and sensitive MBP determination.

Conclusions. In the future perspective, this developed aptasensor can be implemented for development of prototype product for further clinical use in the MBP determination as PoC analysis.

Acknowledgements

- The Scientific and Technological Research Council of Türkiye (TUBITAK), project number 120Z911, 123C351
- EGE University Office of Scientific Research Projects, project number FDK-2020-22395

- Health Institutes of Türkiye (TUSEB), project number 24139

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Topics

Applications

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Development of in-vitro diagnostic platforms for detection of MRC5- and THP1-derived exosomes using optical and chemiluminescent readouts

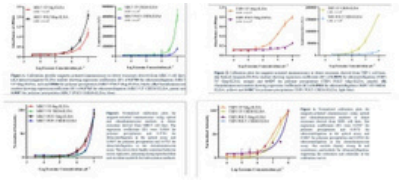
Abstract body:

Background: Exosomes are nanosized extracellular vesicles with high potential as non-invasive biomarkers and therapeutic tools in precision medicine. MRC5-derived exosomes reflect fibroblast physiology and are relevant to lung disease, tissue repair, and aging studies. THP1-derived exosomes simulate monocyte/macrophage dynamics, offering value in immunology and cancer research. However, their small size and biochemical complexity pose analytical challenges. This study presents optimized *in-vitro* diagnostic (IVD) platforms for exosome quantification to support translational applications in disease monitoring and biomarker discovery.

Materials & Methods: Exosomes from MRC5 and THP1 cells were isolated via ultracentrifugation (UF) or polymer precipitation (POLY). Magnetic particles (MPs) functionalized with antibodies antiCD81 (MRC5) or antiCD9 (THP1) were used for capture. Detection was performed with anti-CD63-HRP in magneto-ELISA and magneto-CHEM-ELISA. LODs were derived via 4PL interpolation (average of blanks plus SD).

Results: Standard curves, with LOD, are shown in Figures 1 and 2. Normalized standard curves are shown in Figures 3 and 4. For MRC5, respectively using optical and chemiluminescent readout, LODs were of 4.2×10^5 and 1.4×10^6 exosomes μL^{-1} (POLY), and 7.5×10^5 and 1.1×10^5 (UF). For THP1, respectively using optical and chemiluminescent readout, LODs were 3.6×10^6 and 2.7×10^6 (POLY), and 1.8×10^5 (both, UF). High R^2 values confirmed assay robustness. UF provided superior purity and sensitivity.

Conclusions: The developed IVD platforms enable sensitive, cell-specific exosome quantification. Their adaptability, reproducibility, and clinical relevance support future integration into precision diagnostics for lung disease, cancer, and immune disorders. These results advance the development of standardized tools for exosome-based biomarkers and personalized health monitoring.



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Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Electrochemical Aptasensor for Dickkopf-1 Detection in Liquid Biopsy Samples - An Innovative Approach for Rapid Pancreatic Cancer Screening

Abstract body:

Background:

Pancreatic cancer (PC) ranks seventh among global cancer deaths, with a five-year survival rate of only 8–10%, projected to worsen by 2039. Around 80% of patients are diagnosed too late for surgical resection, and over half present with advanced metastases due to vague symptoms and rapid progression. Even when surgery is feasible, survival remains poor, with high recurrence rates and mainly palliative care. The current biomarker, CA19-9, lacks adequate sensitivity and specificity for early screening. Dickkopf-1 (DKK-1), an inhibitor of the Wnt/β-catenin pathway, is emerging as a promising biomarker due to its abnormal serum levels and involvement in tumor progression. Electrochemical sensors are advantageous for biomarker detection, offering simplicity, speed, low cost, high sensitivity, and good reproducibility. Incorporating biochar - a carbon-rich, eco-friendly material with a three-dimensional structure - can further boost aptasensor performance by increasing active sites for aptamer binding.

Materials & Methods:

This study developed a biochar-based electrochemical aptasensor for the specific detection of DKK-1 as a potential diagnostic and prognostic marker for pancreatic adenocarcinoma. The aptasensor was built on a screen-printed carbon electrode modified with a nanocomposite film of biochar functionalized with carboxyl groups and polycysteine through electrochemical polymerization. Biochar was produced from spent coffee biomass by pyrolysis at 850 °C under oxygen-free conditions, then activated with HNO_3. A DKK-1-specific aptamer was immobilized via amide bonding. Both the biochar and the functionalized electrode were characterized using microscopic, spectrometric, and electrochemical methods. Detection was based on changes in the ferro/ferricyanide redox signal.

Results:
The aptasensor showed strong analytical performance and high selectivity for DKK-1, even in complex samples in the presence of interferents.

Conclusions:
The platform demonstrates significant promise for developing decentralized, portable tools for rapid screening and early diagnosis of pancreatic cancer.

Acknowledgements. This work has been supported by CNCS-UEFISCDI, project number PN-IV-P1-PCE2023-1104, 62PCE/2025 and by Iuliu Haţieganu UMF internal

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Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Electrochemical Biosensor Applications with Carbon-Based 3D Printed Electrodes and Sensor Surfaces

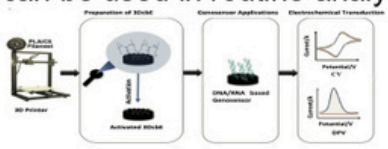
Abstract body:

3-dimensional printing (3DP) technology is gaining importance every day because it allows for diversity in design and portable production. 3DP can realize production in a shorter time compared to traditional methods. The fact that it provides the possibility of production in different geometric shapes allows the advantages of various geometries to be used in different bioanalytical applications. As an alternative to traditional methods, studies are ongoing for cost-effective, fast-to-produce and portable-designed systems for use in point-of-care (PoC) systems.

In this study, a FDM 3D printer working with carbon black and PLA-based filament was used to produce sensor surfaces, which we produce as an alternative to the working electrodes of the triple electrode system in electrochemical sensors. After production, various pretreatment conditions was applied and the conditions under which the best electrochemical performance is shown was optimized. The nanostructure of the sensor surface was observed by SEM method. Then, fish sperm dsDNA and ssDNA oligonucleotide representing Crispr CAS9 are biomodified to 3DcbE's (for label-free detection) for bio-detection. Differential pulse voltammetry technique is used for label-free detection of hybridization. The interaction between DOX and dsDNA was studied to investigate the anticancer drug-dsDNA interaction, which is a key issue for cancer treatment, and it has been shown that the guanine oxidation signal decreases after the interaction of DNA and DOX.

It's envisaged that the functionalization and modulation of the structural properties of CB/PLA electrodes will provide new possibilities for the immobilization of materials with electrocatalytic properties, thereby allowing the detection of a wide range of analytes. With the use of 3D printed working electrodes as a biosensor surface, it is aimed to pave the way for the development of nucleic acid-based biosensors (genosensors) that

can be used in routine analyses for the determination of different biomarkers/molecules in the clinical field.



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Topics

Applications

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Electrochemical detection of extracellular vesicles for early point of care cancer diagnosis and treatment monitoring

Abstract body:

Beating cancer begins with early detection, which enables quicker access to effective treatments and significantly improves long-term survival rates. Although many cancer cases are identified at early stages, the diagnostic pathway typically involves a "two-week wait" for specialist referral, followed by a "31-day wait" to initiate treatment. Thus, developing non-invasive, highly sensitive and cost-effective diagnostic and monitoring systems using small sample volumes for rapid cancer diagnostics is a key strategic priority in personalised medicine.

In this work, we present an ultrasensitive 3D graphene-based electrochemical assay designed for the profiling of tumour-derived extracellular vesicle (tdEV) surface proteins at clinically relevant concentrations, as a tool for early detection of triple-negative breast cancer (TNBC). The 3D graphene electrodes were functionalised with primary antibodies (anti-CD63, anti-CD9, and anti-CD81) using 1-pyrenebutyric acid N-hydroxysuccinimide ester as a linker molecule. These antibodies serve as capture agents, facilitating the immobilisation of EVs on the electrode surface. Binding of tdEVs to the capture antibodies induces changes in surface potential, which modulates the sensor current and generates a measurable electrochemical signal. Each stage of the biofunctionalisation process was validated using electrochemical impedance spectroscopy (EIS), which also quantified the sensor's response to EV binding.

Our graphene-based sensors demonstrated the ability to detect breast cancer-associated proteins at concentrations as low as 5 fg/mL in both spiked buffer and plasma samples. Further, tdEVs expressing TRPC5 surface proteins were harvested from early TNBC cell line models (MCF-7 ADR) via serial ultracentrifugation. Sensor performance was evaluated using tdEVs derived from both TNBC and non-TNBC

cell lines. These findings underscore the potential of our graphene biosensor platform for early point-of-care detection of breast cancer and for monitoring treatment efficacy.

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Topics

Applications

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POSTER

5th European Biosensor Symposium

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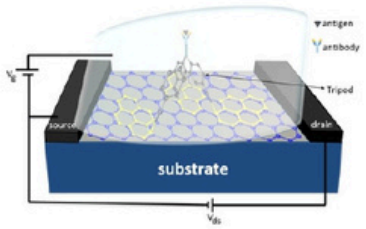
Abstract Title:

Enhanced Graphene Biosensors via Optimized Tripodal Functionalization for Improved Stability and Sensitivity

Abstract body:

Graphene's exceptional properties—including high surface area, electrical conductivity, and mechanical strength—make it a promising material for biosensing. However, its inherent hydrophobicity limits interactions with biomolecules, necessitating a dedicated surface functionalization protocol to enable sensitive and specific detection to happen at the graphene surfaces. While conventional monofunctional linkers (e.g., PBASE) are widely used, tripodal molecules offer superior stability and biomolecule immobilization efficiency, particularly for antibodies and nanobodies. In this work, we present an advanced tripodal design that addresses key challenges related to cost, ease of preparation, sensitivity, and stability. Our approach incorporates shorter-neck alkynes to enable streamlined functionalization via copper-catalyzed click chemistry, thereby optimizing both synthetic accessibility and sensor performance while increasing versatility. Additionally, we demonstrate a scalable fabrication process using cleanroom-based graphene transfer onto quartz crystal substrates (suitable for use in quartz crystal microbalance with dissipation monitoring (QCM-D) equipements) that enable exhaustive quantitative characterization of each step of the functionalization protocol. This innovative tripod based functionalization protocol was consecutively applied to the surface of graphene-based solution-gated field-effect transistors (SGFET), effectively turning them into real time high performance biosensors (Figure 1). Such biosensors sensing performances were tested again Escherichia Coli bacterial target to forecast the potential of this technology in environnemantal monitoring and sanitary surveillance of waters.



Abstract References

References [1] Mann, J. et al Angew. Chem. Int. Ed. 2013, 52, 3177-3180 [2] Alava, T. et al, Anal. Chem. 2013, 85, 2754-2759

Topics

Applications

Alhindi, Mohammad Danish[1]; DEBELA, Ahmed Mehdi[2]; BEDDOK, Claire[3]; FUKS, Gad[2]; ALAVA, Thomas[3]
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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

From Ocean to Lab: Fast and Portable Solutions to Monitor Ciguatera

Abstract body:

Ciguatera is a seafood-borne illness caused by the ingestion of fish contaminated with ciguatoxins (CTXs), which are produced by dinoflagellates. Although traditionally considered restricted to tropical regions, ciguatera is now increasingly reported in temperate areas, highlighting its emergence as a global public health concern. This situation underscores the urgent need for efficient and rapid methods for CTX detection. In our group, we have developed several bioanalytical approaches for the detection of these marine toxins, based on immunological and cellular recognition strategies. Magnetic beads and electrodes coated with multi-walled carbon nanotubes have been employed as supports for capture antibody immobilization. Electrochemical signals from the detector antibodies have been measured using both conventional and portable potentiostats connected to smartphones. Recent efforts have focused on the development of a simple, rapid, single-step assay format. These immunosensors have demonstrated the capability to detect CTXs in fish from the Pacific and Indian Oceans at levels consistent with US FDA guidance. Furthermore, they have shown the ability to discriminate and quantify CTX1B and CTX3C equivalents in cultures of *Gambierdiscus* and *Fukuyoa*, as well as in seawater samples. In parallel, the use of Neuro-2a cells as biorecognition elements has enabled the development of a toxicological biosensor, in which the cells are immobilized on lithographic gold electrodes and their viability is monitored. This cell-based device has successfully detected CTXs in fish from the Atlantic Ocean. Overall, these bioanalytical tools are facilitating the analysis of CTXs and supporting risk assessment for ciguatera, while contributing to ongoing research and environmental monitoring efforts.

Abstract References

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Topics

10 Applications -

Presentation Preference

Oral Communication

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Gut Health Unlocked: Ingestible Sensing from Lab to Human Trials

Abstract body:

Monitoring gut health is very challenging due to the complex structure and inaccessibility of the gastrointestinal (GI). Current invasive techniques, such as upper endoscopy and colonoscopy, cannot fully access the entire GI tract. While capsule endoscopy offers visual inspection of the whole tract, it still requires uncomfortable bowel preparation and cannot measure biochemical properties of the gut environment. To overcome these limitations, we developed and validated an ingestible sensor (1), the Gastrointestinal Smart Module (GISMO). This sensor enables non-invasive, real-time gut health monitoring without the need for bowel preparation, and we have completed its first-in-human trial.

This work focuses on the development and validation of pH and redox sensors used in the GISMO system. It covers extensive preclinical validation through *in vitro, ex vivo,* and *in vivo* models. Benchtop and *in vitro* tests at body temperature measured pH and redox profiles using standard calibration solutions and simulated GI fluids. E*x vivo,* we tested the sensors in real GI fluids from porcine cadaver digesta in an anaerobic chamber. Before the human trial, the *in-vivo* functionality was also validated in living pigs.

In our first-in-human trial, 69 GISMO sensors were administered to 15 healthy participants. These miniaturized, easy-to-swallow capsules (size 0) continuously measure body temperature, pH and redox balance across the GI tract for up to 7.5 days. All capsules were retrieved for post-ingestion lab analysis. The GISMO sensor is the first device to provide real-time redox balance and pH data every 20 seconds. Our data revealed a consistent shift from an oxidizing environment in the stomach to a strongly reducing environment in the colon. This combination of measurements enhanced GI tract segmentation, offering potential for improved diagnosis and monitoring conditions like inflammatory bowel disease (IBD). Further clinical studies will assess GISMO's diagnostic potential in patient populations.

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(1) Van Helleputte, N.; Even, A. J. G.; Leonardi, F.; Stanzione, S.; Song, M.; Garripoli, C.; Sijbers, W.; Liu, Y.-H.; Van Hoof, C. Miniaturized Electronic Circuit Design Challenges for Ingestible Devices. J. Microelectromechanical Syst. 29 (2020) 645. https://doi.org/10.1109/jmems.2020.3006580

Topics

Applications

Sijabat, Ria[1]; Leonardi, Francesca[1]; Even, Aniek[1]; Minderhoud, Roseanne[2]; Torfs, Tom[3]; van Heusden, Arjan[1]; Firfilionis, Dimitrios[1]; Teichmann, Tobias[1]; Van Helleputte, Nick[3]; Van Hoof, Chris[3]
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5th European Biosensor Symposium

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Abstract Title:

Immuno-Capture of Ciguatoxin-like Compounds: a Front-End Strategy for Bioanalytical Detection

Abstract body:

Ciguatoxins (CTXs) are neurotoxins synthesized by marine dinoflagellates within the genus *Gambierdiscus*. CTXs bind to voltage-gated sodium channels on excitable tissues leading to a range of neurological symptoms known collectively as ciguatera poisoning (CP). Humans are usually affected by ingesting contaminated fish. So far, the classification of CTXs analogues depends on their geographic distribution: Pacific, Caribbean, and Indian CTXs.

In this study, we introduce an immuno-capture strategy based on antibodies conjugated to magnetic beads as a preliminary step of a bioanalytical workflow. These antibodies have been produced to specifically recognize different regions of Pacific CTXs: the 3G8 antibody recognizes the left wing of CTX1B, the 10C9 antibody recognizes the left wing of CTX3C, and the 8H4 antibody recognizes the right wing of both. Our approach allows the selective isolation of different CTXs for their subsequent detection with different methodologies, including cell-based assay (CBA) and liquid chromatography-mass spectrometry (LC-MS).

To prove the method, a stomach sample from a toxic shark (*Carcharhinus leucas*) associated with almost a hundred suspected cases of CP was analyzed. An initial screening of the crude extract was performed with sandwich immunoassay and provided positive results for CTXs of the Pacific CTX1B and CTX3C series. However, these toxins were not detected in the follow-up LC-MS analysis. The immuno-capture strategy was then employed and paired with CBA, revealing the presence of additional CTXs outside the expected recognition range of the antibodies. Subsequent LC-MS analysis of the immuno-captured samples indicated the presence of Indian CTXs, implying a potential structural similarity to Pacific CTXs.

Overall, the bio/analytical strategy presented in this work enables the isolation of novel and uncharacterized CTXs analogues and holds potential for clean-up, purification, and enrichment of toxins at trace levels in complex biological and environmental samples as well as integration into biosensing systems.

Abstract References

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Topics

Applications

Incani, Chiara[1]; Cervera, Joan Josep[1]; Reverté, Jaume[1]; Rambla-Alegre, Maria[1]; Tsumuraya, Takeshi[2]; Hirama, Masahiro[2]; Turquet, Jean[3]; Diogène, Jorge[1]; Gracia-Altares, María[1]; Campàs, Mònica[1]
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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

IMMUNOREAGENTS AND IMMUNOASSAYS FOR BIOTOXIN ANALYSIS. PATULIN AS A CASE IN POINT

Abstract body:

Biotoxins are the group of chemical contaminants potentially present in the food chain for which immunoanalytical techniques enjoy a higher degree of implementation in analytical laboratories – supported and recommended, in some cases, by regulatory authorities. Our research group focuses on developing novel immunochemical methods for monitoring toxic chemicals in food and environmental samples. These studies are inspired by three main reasons: (i) the lack of suitable immunoreagents for some toxins; (ii) the search for novel, more appropriate chemical approaches to prepare haptens; and (iii) the demand for cost-effective, rapid analytical methods. Nowadays, our collection of immunoreagents comprises over 500 antibodies with diverse specificities – targeting toxic compounds such as cyanotoxins and mycotoxins – and it is likely one of the largest international repositories of monoclonal antibodies for toxic chemical contaminants. Additionally, various analytical platforms, including ELISA, affinity columns, lateral flow immunochromatography, and biosensors, are assessed for user-friendly and on-site monitoring of biotoxins.

Notably, our laboratory pioneered the development of the first – and currently only – bioconjugates and monoclonal antibodies for the sensitive immunochemical detection of anatoxin-a and patulin through innovative technologies that have since been patented and licensed. As a case in point, a direct competitive ELISA and a lateral flow immunoassay have been developed for the rapid analysis of patulin. These immunoassays were validated by analysing certified contaminated materials. The optimized ELISA was able to accurately and precisely quantify patulin in apple juice at 5 ng/mL, thus encompassing the most demanding European maximum permitted level for infant food products. On the other hand, the developed immunostrips were able to classify in 10 minutes at room temperature the reference samples as complying or not complying with European legislation.

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Topics

Applications

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FLASH PRESENTATION

5th European Biosensor Symposium

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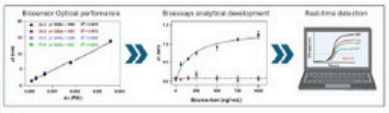
Abstract Title:

Multichannel plasmonic platform for rapid and high-sensitivity multiplexed and comprehensive diagnostics

Abstract body:

We present a compact, multichannel plasmonic biosensing platform designed for the rapid, sensitive, and multiplexed detection of



clinically relevant biomarkers from a single sample [1]. Based on a Kretschmann configuration and integrated with a parallel microfluidic layout, the device enables quasi-simultaneous analysis across four independent channels with high resolution (10 RIU) and excellent inter-channel reproducibility. As a primary application, the platform has been validated for the detection of four key inflammatory and sepsis-related biomarkers—C-reactive protein (CRP), interleukin 6 (IL-6), procalcitonin (PCT), and pancreatic stone protein (PSP)—in human serum, demonstrating high sensitivity (ng/mL range), minimal cross-reactivity, and strong analytical consistency. Its robust optical performance, fast readout time, and disposable design support its use in decentralized settings. The versatility of the biosensor is further highlighted by its ongoing adaptation for the rapid and specific detection and diagnosis of viral and bacterial infections, expanding its potential use in comprehensive diagnostics.

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[1] JF Giarola, P Ramirez‐Priego, MC Estevez, LM Lechuga, Compact Multichannel Plasmonic Device for Rapid and Versatile Inflammatory Biomarker Analysis, Advanced Sensor Research, e00050 (2025)

Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Multifunctional Fe3O4@Au@Pt Nanozymes for Synergistic Chemodynamic and Photothermal Cancer Therapy

Abstract body:

Chemodynamic therapy (CDT) is a promising cancer treatment that generates reactive oxygen species (ROS) through Fenton or Fenton-like reactions in the tumor microenvironment. Nanozymes, a class of nanomaterials with enzyme-mimicking activities, have gained attention as catalysts in CDT due to their high stability, tunable activity, and ability to generate ROS in situ. Particularly, nanozymes that mimic peroxidase or oxidase activity can facilitate continuous ROS production, enhancing therapeutic outcomes. However, CDT alone often suffers from limitations such as insufficient ROS levels in vivo. Therefore, combining CDT with other therapies, such as photothermal therapy (PTT) has gained attention. Hyperthermia induced by PTT can enhance catalytic activity and ROS generation, improving overall therapeutic efficacy.

In this work, magnetic nanoparticles (Fe_3O_4) functionalized with gold (Au) and platinum (Pt) Fe_3O_4@AuNPs@AuX@Pt were synthesized and evaluated as multifunctional nanozymes. These hybrid nanostructures exhibited strong peroxidase-like activity, catalyzing the oxidation of substrates including 3,3',5,5'-tetramethylbenzidine (TMB), o-phenylenediamine (OPD), and gallic acid. Their ROS-generating ability was further confirmed using 2,2-diphenyl-1-picrylhydrazy (DPPH) and methylene blue assays.

Biological studies were performed on human melanoma (A375) and normal keratinocyte (HaCaT) cell lines, demonstrating cellular interactions relevant to therapeutic applications. The magnetic core also offers opportunities for PTT enhancement and targeted delivery.

Fe3O4@AuNPs@AuX@Pt NPs exhibit multi-enzyme-like activity and efficiently generate ROS, with demonstrated catalytic performance both in vitro and in cell-based assays. Their multifunctionality makes them suitable for combined chemodynamic and photothermal therapy, addressing the limitations of CDT

alone. These hybrid nanoparticles represent promising candidates for integrated cancer treatment strategies, with additional possible utility in biosensing.

Abstract References

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Topics

Applications

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POSTER

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Abstract Title:

Polydopamine-Modified Molecular Imprinted Polymers for Polycyclic Aromatic Hydrocarbons Ultrasensitive Detection

Abstract body:

Molecularly imprinted polymers (MIPs) were introduced about 50 years ago by Professor Gunther Wulff to create synthetic polymers with receptor-like properties [1]. The process involves forming a complex between a functional monomer and a target molecule (template), followed by polymerization with a crosslinking agent. Once the template is removed, specific binding sites remain in the polymer. MIPs can be synthesized through bulk polymerization, surface grafting, or electropolymerization. They can be designed to recognize various substances, including inorganic ions, drugs, nucleic acids, and pesticides [2], [3].

This work introduces a self-signaling biosensing platform based on polydopamine-MIP (MIP-pDA) enhanced with Prussian Blue nanoparticles (PBNPs) for highly selective detection of polycyclic aromatic hydrocarbons (PAHs). By leveraging the exceptional specificity of MIPs, the proposed biosensor reported a limit of detection (LoD) of 2.1 ± 0.7 pM (0.5 ± 0.2 ppt), which is significantly lower than current PAHs regulatory thresholds for PAHs (at least three orders of magnitude) [4]. Comprehensive characterization through spectroscopic techniques (ATR-FTIR, Raman, XPS) and electrochemical methods (CV, SWV) confirmed the successful incorporation of PBNPs within the polymer matrix and the precise molecular recognition capabilities of the imprinted cavities. The imprinting process yielded an Imprinting Factor (IF) of 11 ± 3, highlighting the efficiency of the molecular recognition system. The corresponding pDA non-imprinted polymer was further investigated to prove MIP-pDA selectivity and sensitivity. The applicability was demonstrated through recovery studies in complex food matrices, specifically extra virgin olive oil (EVO) with a 93.4% recovery. Future efforts will focus on refining the molecular imprinting strategy and expanding the range of detectable analytes, paving the way for broader industrial and environmental applications. sectors.

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Topics

Applications

Tricase, Angelo[1]; Marchianò, Verdiana[2]; Ditaranto, Nicoletta[2]; Di Franco, Cinzia[3]; Piscitelli, Matteo[3]; Macchia, Eleonora[4]; Scamarcio, Gaetano[5]; Torsi, Luisa[6]; Bollella, Paolo[6]

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POSTER

5th European Biosensor Symposium

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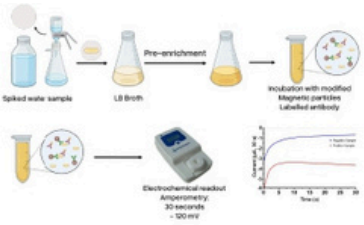
Abstract Title:

Portable Biosensing Device for Coliform Detection in Drinking Water

Abstract body:

The quality of drinking water remains a major cause of preventable mortality worldwide, particularly among young children. Water resources are frequently exposed to a wide range of biological and non-biological contaminants, which, when present above certain thresholds, pose serious risks to human health. Annually, approximately 1.6 million deaths are attributed to waterborne diseases linked to biological contaminants. Identifying contaminated water sources remains a critical challenge, especially in low-resource settings where limited infrastructure hinders effective monitoring and timely intervention. Regular and reliable water quality monitoring is therefore essential to protect public health. Among microbial indicators, Escherichia coli (E. coli) is internationally recognized as the preferred indicator for assessing fecal contamination of drinking water [1].

Currently, culture-based methods are considered the gold standard for detecting waterborne pathogens, including E. coli. However, these methods, as well as commercial detection kits, are often constrained by long incubation times, typically 18-24 hours, which delay critical decision-making. To overcome this limitation, this study presents a novel approach that integrates the ISO membrane filtration standard (ISO 9308-1:2024) with a pre-enrichment step, immunomagnetic separation of E. coli, and electrochemical detection using a new detection platform. This method significantly reduces the time to result, enabling accurate detection of E. coli at regulatory levels (1 CFU in 100 mL) within a single day, thus meeting national and international water quality standards.



The test for coliform detection is rapid, cost-effective, and requires minimal handling, making it an ideal solution for routine industrial water quality monitoring. It can be easily implemented in sectors such as food and beverage production or pharmaceutical manufacturing, where water quality is critical. While primarily designed for coliform detection, the approach is highly adaptable to other water and foodborne pathogens, offering a versatile tool for safeguarding public health and maintaining operational standards in industries.

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Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title: Real-Time Monitoring of Emerging Pollutants to Safeguard Drinking Water Quality

Abstract body: The surrounding environment significantly impacts our health. At least 12 million people worldwide are estimated to die annually due to health problems caused by prolonged exposure to highly polluted areas, and it is estimated that this number will increase 2-fold in 2050. Environmental pollutants, which include both chemical and microbiological agents, contribute to the development of diseases, especially respiratory and cardiac pathologies, and certain types of cancer. This negative health impact, which is a consequence of increasing industrialization, the footprint of urbanization, and the increase in livestock production, highlights the need for continuous monitoring of pollutants in different environments to identify possible health alerts.

Currently, systems for the detection of contaminants in water are based on chromatography and microbiological culture for chemical and microbiological contaminants, respectively. However, these methodologies require highly sophisticated and bulky equipment and a specialized laboratory. These requirements are costly and slow down the time required to obtain results.

In this regard, biosensors have been demonstrated as an alternative detection method, due to their versatility, sensitivity, and ability to provide real-time responses. For these devices to provide a robust response and reliable results, the complexity of the environmental sample must be considered. Therefore, the integration of sample pre-treatment systems into the biosensor, which can condition the sample, remove some critical interferents, or concentrate the analyte, to improve the sensitivity of the device, is of relevance.

Several approaches developed by ITENE in environmental monitoring will be shown in this work, most of them based on the use of biosensors integrated with devices capable of automating both, the sampling and its pre-treatment, as well as the pre-concentration and detection of the analyte. Furthermore, the NIAGARA project will also be presented, the aim of which is to develop solutions capable of reducing the impact of certain pollutants of interest on drinking water.

Figure 1: Schematic representation of the entire project, its partners and the different technologies to be developed within it, including biosensors for the efficient control of drinking water quality.

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Topics

Applications

POSTER

5th European Biosensor Symposium

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Abstract Title:

Sensor-based Ingestible Capsule for Precise GI Fluid Sampling and Microbiome Analysis

Abstract body:

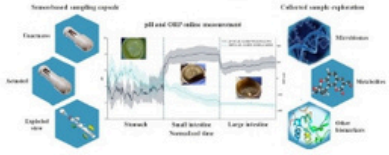
There is a rising demand for accurate sampling of gastrointestinal fluids to better understand the gut microbiome. Traditional methods, such as investigating faeces and endoscopy, have limited informative value or are highly invasive, respectively, thus necessitating improved sampling techniques.

Here, we demonstrate a new sampling capsule, which is in the size of standard 000 pill (26.14 mm length by 9.91 mm diameter). It collects up to 200 µL of fluid, sampling at specific gastrointestinal (GI) tract locations. Using onboard pH, oxidation and reduction potential (ORP), and temperature sensors, the capsule's location along the GI tract is determined precisely. The capsule's onboard antenna allows two-way external control and data retrieval communication, and allows for active sampling triggering. A preloaded quencher liquid inhibits further microbiome activity of the sampled GI liquid.

We conducted an in vivo study and extensive post-trial analysis and demonstrated the capsule's ability to transmit data and successfully sample fluids in various locations in the gastrointestinal tract. Specifically, we show that continuous measurement of pH and ORP facilitates precise determination of capsule location and accurate sampling at targeted sites. Comparing microbiome samples obtained from the ingestible capsule with those from cadaver studies supports the effectiveness of the sampling method and location.

The sampling capsule offers a significant advantage over traditional methods, providing more representative samples. It can collect samples from different locations within the gastrointestinal tract without alteration or contamination. This innovation has the potential to significantly enhance gut analysis and understanding, paving the way for advancements in diagnostic procedures, personalized medicine, and therapeutic

interventions for gastrointestinal disorders by exploring the microbiome, metabolites, or other biomarkers.



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Topics

10 Applications -

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5th European Biosensor Symposium

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Abstract Title:

Thermally induced spontaneous cell detachment: a fast, versatile, and label-free pharmacological approach for assessing drug activity

Abstract body:

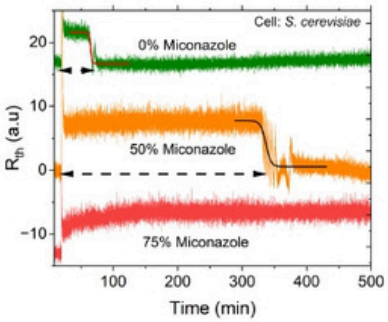
Introduction

The rising threat of antimicrobial resistance, together with the increasing complexity of microbial infections, highlights the need for innovative methods for assessing drug efficacy. Conventional assays, such as disc diffusion, agar dilution, time-kill curves, or flow cytometry are often labor-intensive and time-consuming.[1] Towards advancing pharmacological screening and better prediction of therapeutic outcomes, there is a pressing demand for faster, cost-effective approaches that can provide functional insights into microbial-cell behavior. In this work, we build on the phenomenon of spontaneous cell detachment induced by thermal gradients, as described in reference[2], to investigate the response of *Candida albicans* and *Saccharomyces cerevisiae* to two clinically relevant antifungal agents.

Results and Discussion

Cell suspensions (*S. cerevisiae and C. albicans*) were exposed to various concentrations of ethanol, miconazole, and ciclopirox under a temperature gradient and the cell detachment time, t_d, monitored. Data analysis focused on correlating t_d and drug dose. In addition to performing measurements in nutrient-free medium in the presence of drug, measurements were also performed in cell culture medium to compare detachment-based and proliferation-based responses to drug treatment. For *S. cerevisiae*, t_d is sensitive to as low as 1% miconazole and completely suppressed by concentrations ≥ 75%. Also, ciclopirox concentrations of 0.2% caused significant lengthening of t_d, with no detachment for concentrations of ≥ 1%. Likewise, low drug concentrations of similar range also increase the spontaneous detachment time of *C. albicans* compared to drug-free medium, with a total suppression for ≥ 50% miconazole and 10% ciclopirox. Ethanol also

modulated t_d for both cell types in a dose-dependent way. Finally, we showed that in the presence of nutrients, the drug-modulation of t_d, as well as cell proliferation time, t_p, can be monitored simultaneously.



Conclusion

Spontaneous cell detachment responds sensitively to antifungal drugs, offering a new strategy for pharmaceutical assessment of drug efficacy.

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Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Towards a portable measurement platform for the detection of per- and polyfluoroalkyl substances (PFAS) in soil and wastewater

Abstract body:

Introduction

Per- and polyfluoroalkyl substances (PFAS) can accumulate in nature due to their high stability and liberal use in industrial applications and consumer products. State-of-the-art for the detection of PFAS in soil and wastewater is high-performance liquid chromatography coupled with mass spectrometric detection in a specialized laboratory. The "PFAS-resolve" project aims to develop a system for rapid portable, user-friendly, cost-effective on-site analysis of PFAS-contaminated environmental samples to enable the mapping of contaminated areas.

Discussion

First results on the impedimetric detection of perfluorooctanoic acid by screen-printed electrodes modified with molecularly imprinted polymers were presented by Lourenço et. al at EnFI 2025 [1]. Here, we aim to show an initial concept for the portable impedimetric analysis of PFAS based on the EmStat Pico chip of PalmSens [2]. Initial testing was performed with the Sensit Smart module which is build around the EmStat Pico chip [3]. The possible deployment using a laptop, tablet or smartphone as readout device were evaluated and compared. The core setup may be extended with a possible sample pretreatment by solid-phase extraction and additional control of relevant parameters (i.e., pH, conductivity, temperature).

Acknowledgements

This work was funded by the Interreg Meuse-Rhine (NL-BE-DE) program under IMR6-00027 – PFAS-resolve.

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Topics

Applications

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Towards wearable real-time health monitoring: Aptamer-based biosensors for label-free detection of disease markers in dermal interstitial fluid

Abstract body:

Dermal interstitial fluid (ISF) is a promising alternative to blood as sample for in vitro diagnostic devices. ISF is available with minimally invasive sampling techniques and biomarker concentrations in ISF often reflect concentrations of biomarkers in the blood[1]. This study reports on our research on the development of wearable sensors that will provide a minimally invasive and continuous monitoring system for disease markers using state-of-the-art sensing technologies.

ISF was sampled from healthy human volunteers using a custom 3D-printed microneedle extraction device. We have further performed proteomic profiling and biochemical assays of ISF samples from healthy volunteers, healthy and liver-injured mice to find relevant disease markers. Protein targets were selected to develop the aptamer-based sensors for this work.

The biosensor used for detecting biomarkers in ISF in this study is based on gold electrodes functionalised with aptamers tagged with methylene blue as electrochemical reporter molecules. The target-induced conformation changes in the aptamer alter the efficiency of electron transfer of methylene blue with the electrode surface as previously described[2]. The electrochemical signal of methylene blue was monitored using square wave voltammetry and electrochemical impedance spectroscopy.

The biosensor was successfully applied in a microfluidic set-up showing reliable binding kinetics with the protein target and demonstrating the potential for continuous monitoring of disease markers. Validation of the developed sensors is done on real clinical samples. With its current performance and potential for integration with minimally invasive sampling strategies, the electrochemical aptamer sensors could pave the way for wearable sensors to continuously monitor disease markers in dermal interstitial fluid and could revolutionise the way we diagnose to prevent and treat diseases.

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Translating Biomarker Discovery into Point-of-Care Biosensors: Advancing Prognostic Tools for Malaria

Abstract body:

Background

Malaria remains a major global health challenge, especially in endemic regions with limited healthcare infrastructure where syndromic assessment often guides clinical decisions [1]. While diagnostic tools have improved, prognostic tools to assess disease severity and support resource allocation are still lacking (Figure 1). Effective prognosis requires quantification of parasite-derived and/or host-response biomarkers [2].

Materials & Methods

We measured *Plasmodium falciparum* lactate dehydrogenase (PfLDH) and angiopoietin-2 (ANG2) as parasite and host biomarkers, respectively, using enhanced lateral flow assays and electrochemical aptamer-based (EAB) biosensors.

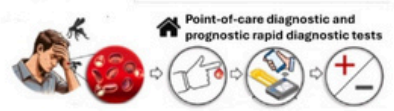
Results

Commercial lateral flow assays (LFAs) for PfLDH and HRP2 were adapted using a smartphone-based video analysis method [3], capturing dynamic colorimetric changes to enable semi-quantitative readouts from qualitative strips [4]. This low-cost enhancement allows immediate extension of LFAs to provide prognostic information. In parallel, we developed EAB biosensors [5] for PfLDH [6] and ANG2, enabling real-time, label-free quantification in minimally processed samples. These sensors demonstrated high sensitivity and specificity, supporting their use in point-of-care settings.

Conclusions

By integrating parasite and host biomarkers into accessible diagnostic platforms, we advance malaria tools

beyond detection toward actionable prognosis, improving triage and resource use in low-resource settings.



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Topics

Applications

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Wearable sensor for plant health monitoring

Abstract body:

With increasing threats to global agriculture from climate change and environmental degradation, continuous plant health monitoring has become critical. Electrophysiological (EP) signals offer a non-destructive, real-time window into plant responses to environmental stress. However, existing non-invasive EP monitoring techniques face limitations in long-term stability due to dehydration and poor contact on complex plant surfaces. In contrast, commercial invasive electrodes—while capable of long-term operation—can damage tissues and alter physiological states.

In this presentation, I will introduce a long-term wearable sensing platform designed for stable and non-invasive monitoring of plant EP signals. The system integrates a soft, conformal interfacial layer that maintains contact across diverse leaf topographies. This bioelectronic interface enables reliable signal acquisition for one month, surpassing typical lifespans of non-invasive sensors.

I will discuss the material design strategy for achieving durable electrode-plant interfaces, and present key findings from long-term monitoring of stress response of plants. The sensor's capability to track EP signal changes over multiple days enables insights into the dynamic physiological responses of plants under stress, which are often missed by short-term studies.

This work lays the foundation for deploying bioelectronic sensors in precision agriculture, offering new opportunities to monitor plant health continuously and sustainably in the field.

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Luo, Y.; Li, W.; Lin, Q.; Zhang, F.; He, K.; Yang, D.; Loh, X. J.; Chen, X. Advanced Materials 2021, 33 (14), 2007848.

Topics

Applications

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BIOHYBRID INTERFACES

POSTER

5th European Biosensor Symposium

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Abstract Title:

Biodegradable Pullulan-Coated Cable Bacteria for Transient Electronics and Biosensing Applications

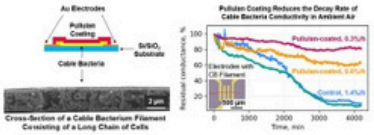
Abstract body:

Transient electronics, including electronic biosensors, have emerged as a significant area of research in response to the rapidly growing problem of electronic waste accumulation [1,2]. These devices should utilize biodegradable polymers and hence be preferentially bio-based. The recent discovery of extremely long (>1cm) and highly conductive wire structures (>100 S/cm) in cable bacteria opens new perspectives for bio-inspired electronics [3,4]. However, the conductance of this material decreases upon exposure to oxygen.

Therefore, the current work aimed to evaluate the effectiveness of protective coatings to reduce the negative impact of oxygen on conductance. One such potential coating is pullulan - a film-forming polysaccharide polymer produced by yeast-like fungi and known for its excellent oxygen barrier properties [5]. Pullulan has already been used to extend the shelf life of food and viral vaccines [6,7], but its potential for transient electronics has not yet been sufficiently explored.

Here, pullulan was used to cover the oxygen-sensitive cable bacterium filaments. To this end, the bacterial filaments were first deposited on the gold electrodes in an oxygen-free environment. The homogeneous pullulan film was formed by drop-casting the 10 wt% pullulan-water solution on the samples and left to dry for 24 hours. After the film was formed and the samples were transferred to ambient air, electrical characterization was carried out by continuous I/V profiling.

Our results show that, compared to the control, the pullulan coating successfully preserved the conductivity of the cable bacterium filament, reducing the decay rate of initial conductivity from 1.4% to 0.6%/hour. This proves that the oxygen barrier properties of pullulan make it a suitable coating for applications in sustainable electronics and biosensor development. Further efforts to increase film thickness and improve adhesion will allow enhanced protection, paving the way for robust transient electronics.



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Topics

Biohybrid interfaces

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5th European Biosensor Symposium

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Abstract Title:

Formate detection with formate dehydrogenase: Comparing direct and mediated electron transfer

Abstract body:

Formate is a key intermediate in various biochemical and industrial processes and serves as an important indicator in several fields ranging from environmental monitoring to clinical diagnostics. Accurate and selective detection of formate is therefore of importance for both analytical and biotechnological applications. Enzyme-based biosensors, particularly those employing formate dehydrogenase (FDH), offer a promising approach due to the enzyme's high specificity and efficiency in catalyzing the oxidation of formate to carbon dioxide (in addition to the reverse reaction)[1].

In this study, we investigated the electrochemical properties of FDH immobilized on electrodes via two distinct approaches: adsorption onto a bare gold electrode (enabling direct electron transfer, DET) and incorporation into a redox polymer containing osmium complexes (facilitating mediated electron transfer, MET). The resulting bioelectrodes were characterized by cyclic voltammetry in a potential range from –100 mV to +600 mV vs Ag/AgCl.

Both electrode configurations showed catalytic currents that correlated with formate concentration, confirming the functional immobilization and activity of FDH in each case. However, the MET-based electrode exhibited significantly higher catalytic currents—more than twice compared to those observed for DET configuration. This enhancement can be attributed to an increased amount of coupled enzyme molecules enabled by the Os-polymer, which acts as an effective shuttle between the enzyme's active site and the electrode surface.

These findings emphasize the importance of electron transfer mechanisms in FDH-based biosensor design. While DET offers a simple and straightforward setup, the MET-based system provides higher sensitivity, but introduces a third component. Both formats seem to be attractive for practical sensor applications requiring reliable formate detection.

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Topics

11 Biohybrid interfaces -

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5th European Biosensor Symposium

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Abstract Title:

High-throughput Screening of Insect Odorant co-receptor Expression for Biosensor Fabrication

Abstract body:

Introduction - Artificial odor sensors offer enormous potential from drug and explosive detection to biomedical applications. The well-characterized insect olfactory system serves as an excellent model system for this type of sensor. Insect olfactory receptors are heteromeric transmembrane proteins, composed of a highly-conserved co-receptor (Orco) and a diverse set of ligand-binding odorant receptor (OR). Membrane protein expression poses significant challenges due to their dependence on specific membrane lipid environments. Synthetic membranes (liposomes) can be manufactured in a laboratory environment, the preparation is often time-consuming. Here, we implemented robotic ethanol injection for liposome fabrication, enabling rapid generation of liposomes with diverse lipid compositions, facilitating high-throughput screening.

Results and Discussion - Transmission electron microscopic (TEM) was used to assess the quality of ethanol-injected liposomes in comparison to extruded DOPC liposomes. The liposomes are predominantly round to elliptical, with an overall homogenous size distribution and intact membranes (**A & B**). Zetapotential of DOPC:DOPG liposomes with varying compositions were analyzed and compared to get an insight into the surface charge and stability. The zetapotential reveals two peaks for ethanol-injected liposomes, with a lower intensity for the second. Overall, the zetapotential values are comparable to the extruded liposome control (**C**). For expression, *Aedes aegypti* Orco was selected. Conventional extruded DOPC liposomes served as control for expression parameters. A denaturing SDS-PAGE was used for expression verification (**D**). Fluorescence detection was based on a C-terminal tetracysteine minihelix, which binds the dye FlAsH-EDT2. The fluorescence assay demonstrates that the ethanol-injected liposomes are equally suitable as extruded liposomes for expression of the membrane protein Orco (**D**).

We present a liposome production method enabling high-throughput testing of liposome compositions for the expression of olfactory receptor proteins in the context of biosensor fabrication.

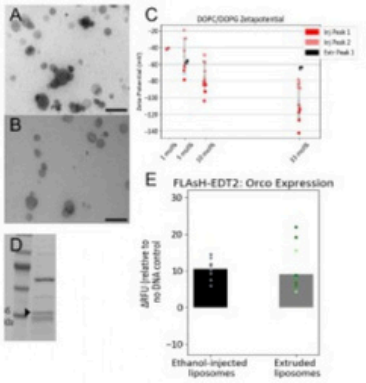

Figure 1: A: TEM image from extruded DOPC liposomes, B. TEM image from ethanol-injected DOPC liposomes, scale

Abstract References

Acknowledgments - This work is part of the project SYNCH: Combining SYnthetic Biology & Neuromorphic Computing for Chemosensory perception, funded by the Volkswagen Foundation under the call NEXT-Neuromorphic Computing

Topics

11 Biohybrid interfaces -

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Abstract Title:

Hybrid Molecular Recognition Engine: Aptamer-MIP Sensor for Detection of Organophosphorus Pesticide

Abstract body:

Organophosphorus pesticides, particularly Diazinon, pose significant risks to both environmental and public health. Traditional analytical detection techniques, while effective, are often limited by high costs, complex instrumentation, and long analysis times [1]. To overcome these limitations, aptamer-based sensors (aptasensors) and molecularly imprinted polymers (MIPs) have emerged as powerful alternatives due to their high selectivity, sensitivity, and adaptability [2]. In this study, a biohybrid Aptamer-MIP (Apt-MIP) sensor was proposed for the sensitive and selective detection of Organophosphorus pesticides, Diazinon. The design involved an Apt-MIP hybrid sensor combining the high specificity of aptamers with the structural recognition capabilities of MIPs. The sensor surface was sequentially modified with an aptamer layer followed by MIP polymerization, ensuring both biological and chemical recognition mechanisms. Following a one-hour incubation of the diazinon-specific aptamer at 37 °C, the system underwent an additional optimization step involving a waiting period ranging from 1 to 18 hours. Based on these trials, a 3-hour storage at 4 °C was selected as optimal. Subsequently, electropolymerization was performed using o-phenylenediamine, with the number of cycles optimized between 30 and 60. Optimal polymerization was achieved at 60 cycles. The template was removed using methanol over one hour to create specific recognition sites. The developed sensor exhibited excellent selectivity toward Diazinon even in the presence of structurally similar pesticides such as monocrotophos, propetamphos, buprofezin, and chlorfenvinphos. The sensor showed a linear response to Diazinon concentrations in the range of 3.28 pM to 0.16 nM, with a limit of detection of 1.25 nM. Analytical performance was further validated through recovery studies in tap water samples, yielding satisfactory recovery rates. Recovery experiments using Diazinon-spiked tap water samples yielded recoveries ranging from 98.51 % to 99.70 %, validating the sensor's applicability.

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Topics

Biohybrid interfaces

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Abstract Title:

Metal Nanoparticle-Based Strategy for Enhanced Contrast in XRF Imaging

Abstract body:

X-ray fluorescence (XRF) imaging is a powerful technique for mapping elemental distributions, particularly metals, in biological tissues [1]. However, its broader application is constrained by the scarcity of effective contrast agents. To address this limitation, we developed a novel strategy that uses an approach to trigger site-specific growth of metal nanoparticles (NPs) in situ, enhancing spatial resolution in biological XRF imaging [2].

This synthesis strategy achieves three key advances:

(1) Biomarker-specific signal localization; (2) Significantly enhanced image contrast; (3) Compatibility with complex cellular architectures.

By employing this strategy, we anticipate notable improvements in image contrast and specificity, which may substantially broaden the utility of XRF imaging in biomedical research.

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Topics

Biohybrid interfaces

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5th European Biosensor Symposium

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PEDOT:PSS -- A suitable electrode interface for the enzyme PQQ-GDH

Abstract body:

Due to the electronic conductivity, PEDOT:PSS is a valuable material in biosensor research. It may also act as a reaction partner of enzymes and thus allow the construction of enzyme electrodes.

This has already been demonstrated for other conducting polymers, such as polyanilines [1] or polythiophenes [2]. Consequently, first reports on direct electron exchange have also appeared for the combination of PEDOT:PSS and some proteins such as cytochrome c [3], cellobiose dehydrogenase [4], FAD-dependent glucose dehydrogenase [5], and others [6-8].

In this study, we have investigated whether layers of PEDOT:PSS deposited on gold electrodes can serve as an interaction partner for the enzyme PQQ-dependent glucose dehydrogenase (PQQ-GDH). Utilizing cyclic voltammetry and impedance spectroscopy, successful polymer immobilization was demonstrated. Voltammetric experiments, both with and without glucose in solution, showed a substrate-dependent catalytic current starting at potentials of about +150 mV vs Ag/AgCl. This indicates a direct electron transfer between PEDOT:PSS and PQQ-GDH. This conclusion is supported by impedimetric experiments in the presence of glucose.

In further experiments, some properties of an enzyme electrode based on this combination of PEDOT:PSS and PQQ-GDH have been studied. For instance, the dependence of the catalytic current on the polymer layer thickness and the activity of the enzyme applied was investigated. The current signal shows a substrate dependency according to the Michaelis-Menten kinetics, resulting in an apparent Km of about 0.5 mM D-glucose at pH 6.5.

These direct electron transfer systems may provide the basis for the further integration of enzyme reactions into bioelectronic circuits.

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Topics

Biohybrid interfaces

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Ratiometric Sensing of pH, Oxygen, Temperature, and Saccharides Using Multicolored Nano- and Microsensors

Abstract body:

In the last years, the development and application of nano- and microsensors for the optical monitoring of a broad range of analytes in complex biological and environmental systems has rapidly increased. In this work we present the design and characterization of multifunctional nano- and microsensors for the selective detection of neutral and ionic target analytes, based on polystyrene and silica particles combined with multi-color analyte-responsive chromophores. [1-3] These particles with sizes ranging from 25 nm to several microns were synthesized with a high monodispersity and tailored surface chemistries. For the ratiometric optical detection of parameters such as temperature and analytes including protons/pH, oxygen, and sugars, oxygen-responsive and thermo-responsive luminophores, as well as boronic acid-based saccharide receptors, were utilized. These components were either embedded within the particle matrix or covalently attached to the particle surface. In addition, multi-color emissive pH-sensitive dyads, that combine analyte-sensitive and inert reference dyes, were used to broaden the measurable pH range or enable simultaneous multi-parameter sensing. Compared to conventional molecular probes, these nano- and microsensors reveal an enhanced brightness (i.e., amplified signals), ease the design of ratiometric systems, and increase dye photostability. Moreover, such particle sensors enable the use of hydrophobic dyes in aqueous environments.

Subsequent stability and biocompatibility studies of the nano- and microsensors in aqueous media, physiological buffers, and cell culture environments, confirmed the applicability of these systems for analyte detection and long-term monitoring in biological systems. In vitro cell studies demonstrated the sensors' ability to monitor intracellular and extracellular changes in real time without cytotoxic effects. Furthermore, integration into microfluidic platforms enabled dynamic sensing in controlled flow environments, mimicking physiological conditions and enabling high-throughput analysis.

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Topics

Biohybrid interfaces

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Abstract Title:

Real-time monitoring of dopamine release from midbrain organoids using 3D pyrolytic carbon electrodes

Abstract body:

The emergence of human pluripotent stem cell-derived organoids has boosted in vitro models by unlocking new means to study the underlining causes of neurodegenerative diseases like Parkinson`s. We explore brain region specific ventral midbrain (VM) and striatum (STR) organoids to recapitulate on chip the main area of the brain associated with the dopaminergic circuitry, namely, the nigrostriatal pathway (NSP).

Two different 3D electrode designs were fabricated using pyrolysis in which a polymeric precursor is converted into pyrolytic carbon in a high temperature furnace (900 °C) at inert atmosphere. The polymer precursor was 3D printed on a silicon substrate as reported in [1]. In design 1, 3D pillar cup-shaped structures were designed to increase the electrode surface area as well as to confine a single mature organoid (day 90) during measurement. In design 2, a Kelvin cell structure was explored for potential use as a 3D scaffold for organoid culture in which progenitor organoids (day 16) were seeded and cultured until day 90. The organoids cultured on the carbon electrodes were characterized at different times points using SEM. To enable optogenetic experiments, a third planar carbon electrode design was fabricated using UV lithographically patterned SU-8 on a fused silica wafer, which then was pyrolyzed into carbon [2]. Subsequently, SU-8 pillars were patterned on top of the planar carbon electrode to serve as optical waveguides for light stimulation of cells (optogenetics). A printed circuit board (PCB) containing a blue light emission diode (LED) connected to a microcontroller was used for the optogenetic setup.

Characteristic real time exocytosis events were recorded from both Matrigel embedded and non-embedded VM organoids, with a single organoid confined in a 3D carbon cup electrode. Exocytosis was triggered either by chemical stimulation or by light with exocytosis events observed in both cases.

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Topics

09 Other devices -

Maraschin, Samuel T. S.[1]; Thongkorn, Surangrat[2]; Emnéus, Jenny[3]; Kanakkottu, Swetha[4]; Rezaei, Babak[4]; Scordo, Giorgio[2]; Sozzi, Edoardo[5]; Parmar, Malin[5]; Heiskanen, Arto[1]; Sylvest Keller, Stephan[1]

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Abstract Title:

Scalable Graphene Foam Biosensors for Point-of-Care Diagnostics of AMR and Pandemic Threats

Abstract body:

The dual threats of emerging pandemic-potential pathogens and escalating antimicrobial resistance (AMR) create an urgent need for diagnostic tools that are not only rapid and accurate but also adaptable to unforeseen challenges [1,2].

To meet this demand, we have developed a sensitive, label-free electrochemical biosensor by leveraging the advantages of graphene foam (GF) and peptide nucleic acid (PNA) probes. The GF electrode provides superior electroconductivity and a large active surface area[3], while PNA probes offer enhanced binding affinity and specificity for target nucleic acids compared to conventional DNA probes [4].

We report a universal and direct functionalisation strategy employing pyrene-modified PNA probes to preserve the excellent electronic properties of GF, with optimised probe density to ensure the efficient target capture. Using Electrochemical Impedance Spectroscopy (EIS) for detection, our GF-PNA biosensor demonstrates sensitive detection of the colistin resistance gene, *mcr-1*. It achieves a limit of detection (LoD) of 80 nM for size-matched ssDNA, which is improved compared to a 200 nM LoD previously achieved on screen-printed carbon electrodes[5], and realises a clinically relevant LoD of 7.43 pM for *E. coli* plasmids. Notably, we have further accelerated the functionalisation with a heat-assisted strategy that dramatically reduces the surface preparation time from 18 hours to just two minutes, without compromising analytical performance. The platform exhibits high specificity, robust storage stability, and versatility for adaptation to other genetic targets.

This work establishes a versatile and stable biosensing platform by combining a facile and rapid functionalisation method with highly sensitive materials, highlighting a significant advance towards the scalable manufacturing of diagnostics for AMR and future pandemic preparedness.

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Topics

Biohybrid interfaces

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BIORECEPTORS

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Abstract Title:

A DUAL APTASENSOR FOR INFLAMMATORY CYTOKINES DETECTION IN BIOLOGICAL FLUIDS

Abstract body:

Cytokines, signaling biomolecules, play an important role in cell proliferation, immune responses, inflammation, and various cancer-related processes. Due to their important functions, they serve as valuable biomarkers for diagnosing a range of medical conditions and monitoring responses to pharmacological treatments. Therefore, the sensitive and selective detection of cytokines has practical applications [1, 2]. In this regard, our study focused on developing a tailored platform for the simultaneous and specific electrochemical detection of Interleukin-6 (IL-6) and Tumor Necrosis Factor-α (TNF-α) in biological fluids, with potential applications in both biomedical research and clinical diagnostics.

The aptasensor was fabricated based on in-lab printed electrochemical cells. To enhance detection sensitivity, the working electrodes were functionalized with Au and Pt nanoparticles. Two specific aptamers, each functionalized with a distinct redox label, were employed to ensure high specificity in detecting the target cytokines. Each modification step was validated using cyclic voltammetry and electrochemical impedance spectroscopy.

The dual aptasensor was thoroughly evaluated in terms of its analytical performance, confirming its capability for the selective and simultaneous detection of IL-6 and TNF-α. The optimized sensor platform was applied to the analysis of real biological samples, specifically saliva and sweat collected from both patients and healthy individuals. To validate the obtained results, the same samples were tested using an ELISA technique, and the results were statistically analyzed.

The developed aptasensor demonstrated effective, specific, and simultaneous electrochemical detection of IL-6 and TNF-α, emphasizing its potential for use in medical diagnostics.

Acknowledgements: This work has been supported by CNCS-UEFISCDI, project number PN-IV-P1-PCE-2023-1104, 62PCE/2025.

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Topics

Bioreceptors

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Abstract Title:

A Dual-Electrode MIP/NIP System with Voltage-Controlled Regeneration Towards Continuous L-Lactate Sensing

Abstract body:

Continuous L-lactate monitoring is key in health and fitness tracking, and industrial bioprocess control **[1]**. However, its poor electrochemical activity at conventional electrodes hampers direct detection **[2]**. Molecularly imprinted polymers (MIPs) are promising synthetic receptors, offering tailor-made selectivity **[3]**. Yet, their strong analyte binding typically limits reversibility in continuous sensing formats. Here, we present a regenerable dual-electrode system using polypyrrole-based MIPs for reversible impedimetric determination of L-lactate, with a non-imprinted polymer (NIP) electrode enabling signal correction.

MIP and NIP films were electropolymerized *via* cyclic voltammetry on screen-printed carbon electrodes, with or without L-lactate as the template. Impedimetric sensing with reversible analyte binding was performed in 0.1 M NaCl using a four-step voltage protocol: (1) prepolarization at a positive potential, (2) L-lactate binding, (3) L-lactate removal *via* negative bias, and (4) re-doping to restore Cl^- counterions and baseline impedance (Figure 1a).

The MIP electrode exhibited selective L-lactate binding over a linear range of 5 – 30 mM, encompassing clinically relevant concentrations. While polypyrrole's redox activity enables stimulus-responsive behavior, it also leads to dopant ion loss and signal drift **[4]**. The NIP electrode served as a control to correct for non-specific adsorption and de-doping effects. NIP signal subtraction improved accuracy and reliability of L-lactate measurements (Figure 1b). The sensor maintained consistent performance over five regeneration cycles, with baseline impedance reliably restored after each (Figure 1c).

This voltage-controlled, dual-electrode MIP sensor uniquely integrates reversible L-lactate determination, electrochemical regeneration, and signal correction. It addresses key challenges of conventional MIP sensors

and presents a promising platform for continuous, real-time L-lactate monitoring in biomedical and biotechnological applications.

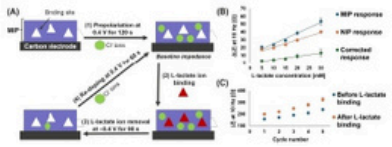

Figure 1. Sensor principle and performance: (a) voltage-controlled regeneration of MIP receptor, (b) dose-response curves, (c) MIP signal stability over five regeneration cycles with 15 mM L-lactate. Error bars represent standard error (n = 3).

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Topics

Bioreceptors

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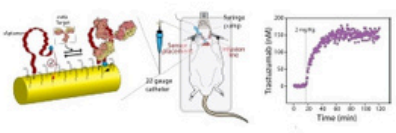
Abstract Title:

An Electrochemical Aptamer-Based Biosensor for In Vivo, Real-Time Pharmacokinetic Monitoring of Trastuzumab

Abstract body:

Many drugs exhibit significant pharmacokinetic variability, rendering precise patient dosing challenging [1]. Current therapeutic drug monitoring (TDM) is often impractical due to slow, cumbersome methods requiring blood draws and centralized lab analysis [2]. To address this, we developed and compared two electrochemical DNA-based platforms: a DNA scaffold sensor [3,4] (Figure 1, left) and an aptamer-based (EAB) sensor [5] (Figure 1, right) for detecting the biologic cancer drug, Trastuzumab. While both platforms offer rapid measurements, the E-AB sensor exhibited superior analytical performance with a nanomolar affinity (Kd of 40 ± 6 nM) and a significantly larger signal response (47.4 ± 1.7%). The excellent performance and rapid response of the E-AB sensor in whole blood make it ideally suited for point-of-care applications. Next, we adapted EAB sensor to support implantable sensors and we showcase its successful implementation for the real-time, in vivo quantification of Trastuzumab in living animals. This breakthrough technology paves the way for a new generation of biosensors capable of providing immediate feedback for personalized drug dosing, ultimately enhancing therapeutic efficacy and patient safety.



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Topics

Bioreceptors

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Abstract Title:

Aptamers developments for use in diagnostics

Abstract body:

Aptamers can bind specifically to targets ranging from small molecules to complex structures, making them suitable for a variety of diagnostic and therapeutic applications. In analytical scenarios, aptamers are used as molecular recognition molecules instead of or in combination with antibodies in the form of competitive or sandwich assay formats. These can be realised by MTP-based assays, strip tests or aptasensors.The aptamer target molecules are often biomarkers for specific diseases, such as human neutrophil elastase (NE), which plays an important role in the development of chronic obstructive pulmonary disease (COPD). On the other hand, the urokinase-type plasminogen activator (urokinase, uPA) is a much-discussed biomarker for cancer prognosis and diagnosis. Highly specific ssDNA aptamers have been developed for the sensitive detection of uPA in human urine and have also shown a high potential for inhibiting various biological uPA functions, which opens up the prospect of using these aptamers as therapeutic agents.

Abstract References

Dreymann, N., Sabrowski, W., Danso, J., & Menger, M. M. (2022). Aptamer-Based Sandwich Assay Formats for Detection and Discrimination of Human High- and Low-Molecular-Weight uPA for Cancer Prognosis and Diagnosis. Cancers, 14(21), 5222. https://doi.org/10.3390/cancers14215222 Dreymann, N., Wuensche, J., Sabrowski, W., Moeller, A., Czepluch, D., Vu Van, D., Fuessel, S., & Menger, M. M. (2022). Inhibition of Human Urokinase-Type Plasminogen Activator (uPA) Enzyme Activity and Receptor Binding by DNA Aptamers as Potential Therapeutics through Binding to the Different Forms of uPA. International Journal of Molecular Sciences, 23(9), 4890. https://doi.org/10.3390/ijms23094890

Topics

Bioreceptors

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Autoinducer Peptides as Biomarkers for Lower Respiratory Tract Infections: ELISA Development and Clinical Application

Abstract body:

Background

The diagnosis of *S. aureus* infections remains a challenge. Traditional culture methods are time-consuming and often delay the initiation of appropriate therapy. Rapid and reliable diagnostic tools are urgently needed[1]. Quorum sensing is a cell-to-cell communication system that may be considered a potential biomarker of infection [2]. Studies revealed that at certain concentration of bacteria, the QS is starting to be released so, their detection can be used for early stage of an infection [3]. Autoinducer peptides (AIPs) are QS molecules that are released specifically from *S aureus*.

Methods

Monoclonal antibody (MAbs) was produced for the detection of AIP1 using as immunogen AIP1c-KLH immunogen. The MAbs were produced using hybridoma technology. The ELISA developed was tested for the direct detection of AIPs in BAS using spin column based on immunoaffinity extraction. We developed an easy and fast immunoaffinity clean-up protocol that fits perfectly with the developed ELISA.

Results

The developed ELISA consisted in an indirect competitive immunoassay (mAb23/AIP4S-BSA) that allowed the detection of the AIP1 with a LOD of 2.49±0.78 nM and a dynamic range of 5.74±1.21 to 68.72±2.91 nM. The ELISA was selective for AIP1 which were an impressive result taking into consideration that AIP1 share the same aminoacid sequence that AIP4, except one aminoacid. After testing different clean-up procedures, spin-IA column revealed the best performance an allowed the detection of AIP1 in a complex matrix like BAS

in 30 min in addition to the standard ELISA protocol (1h 30min). Clinical samples were analysed from BAS patient confirmed the presence of AIP1 in LRT infected sample for S aureus

Conclusions

For the first time, AIPs were detected in clinical samples. The developed technology open and provide a new tool for the establishment of AIPs as an early detection biomarker for S aureus infection.

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1. Tong SY, Davis JS, Eichenberger E, Holland TL, Fowler VG Jr. Staphylococcus aureus infections: epidemiology, pathophysiology, clinical manifestations, and management. Clin Microbiol Rev. 2015 ;28(3):603-61 2. Miller, M. B.; Bassler, B. L., Quorum sensing in bacteria. Annu Rev Microbiol 2001, 55, 165-99 3. Montagut EJ, Acosta G, Albericio F, Royo M, Godoy-Tena G, Lacoma A, Prat C, Salvador JP, Marco MP. Direct Quantitative Immunochemical Analysis of Autoinducer Peptide IV for Diagnosing and Stratifying Staphylococcus aureus Infections. ACS Infect Dis. 2022 Mar 11;8(3):645-656.

Topics

Bioreceptors

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ORAL COMMUNICATION

5th European Biosensor Symposium

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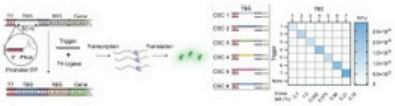
Abstract Title:

Base Gap switches: a novel class of molecular switch for synthetic biology-driven biosensors

Abstract body:



Synthetic gene circuits combine evolutionarily optimized biological processes, synthetically engineered nucleic acid circuits, and *in vitro* transcription/translation to produce detectable signals in response to disease. A major advantage of SGCs is their potential for *multiplexing*; different circuit and target combinations can be programmed to express unique proteins, thereby differentiating diseases in panel tests. Central to most SGC-based biosensors are molecular "switches" that modulate protein expression in the presence of disease targets. Unfortunately, contemporary switches suffer from a propensity to express protein in the absence of the target ("leakage") or presence of unrelated targets ("crosstalk"). This limits their sensitivity, specificity, and orthogonality. They are also typically designed around hairpin structures, which introduce sequence constraints. These hurdles have prevented widespread adoption of SGC-based biosensors.

In this talk, I will describe a new class of switch, termed "Base Gap switches", that overcome these limitations. I will show how the unique design of Base Gap switches enables unprecedentedly low leakage, resulting in greater test sensitivity. Moreover, I will outline how the simple design and facile synthesis of Base Gap switches facilitates their rapid adaptation to novel targets. I will discuss how these flexible new biosensors can be used to control the expression of fluorescent proteins (e.g., mNeonGreen, mNeptune, Sirius), enzymes (e.g., restriction enzymes), luciferases (e.g., nano luciferase), and short peptides. I will also detail how Base Gap switches minimise crosstalk to facilitate multiplexed sensing, and also how they can be used to discern single-nucleotide variants (SNVs). Finally, I will demonstrate the potential of this technology by describing several novel bioassays, including an ultra-sensitive assay for single-copy number detection of *Trichomonas*

vaginalis, a one-pot multiplexed assay for differentiating gonorrhoea and chlamydia infections, and a test for detecting single-nucleotide polymorphisms (SNPs) in circulating tumour DNA.

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1. Partington, Y. et al.....Daniel A. Richards*, Base Gap Switches as Transcriptional Regulators and Their Applications as Biosensors, Nature Sensors (manuscript under consideration). 2. Green, A. A., Silver, P. A., Collins, J. J. & Yin, P. Toehold switches: De-novo-designed regulators of gene expression. Cell 159, 925-939 (2014). 3. Silverman, A.D., et al. Cell-free gene expression: an expanded repertoire of applications. Nature Reviews Genetics 21, 151-170 (2020).

Topics

Bioreceptors

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ORAL COMMUNICATION

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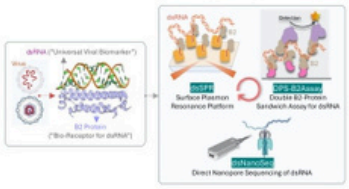
Abstract Title:

Biosensing of dsRNA, a Universal Viral Biomarker: Coupling Protein-Based Sandwich Assay with Nanopore Direct RNA Sequencing for Emerging Infectious Disease Surveillance

Abstract body:

Double-stranded RNA (**dsRNA**) is a universal pathogen-associated molecular pattern,[1] and nearly all viruses produce dsRNA in their life cycle,[2] making it a crucial biomarker for **emerging infectious diseases** (EIDs)[3] detection, particularly those caused by unknown viruses. Surprisingly, dsRNA-centered approaches for virus sensing are hard to come by and remain underrepresented in the current literature. Here, we report a sensitive, scalable, and selective dsRNA biosensing setup by structurally engineering the B2 protein (from Flock house virus)[4,5] as a bioreceptor. First, site-oriented immobilization of B2 is achieved by a SpyCatcher:SpyTag system[6] over gold surface, and B2-dsRNA binding kinetics are decoded through a portable SPR (**dsSPR**), revealing that B2 has a lower nanomolar order affinity (KD ~8.6 nM) for *bona fide* viral dsRNA similar to the gold standard J2 antibody[7] (6.4 nM). This high affinity is leveraged to design a double B2-protein sandwich assay for dsRNA surveillance (**DPS-B2Assay**), offering high commercial relevance due to the low production cost of recombinant proteins compared to monoclonal antibodies. The DPS-B2Assay is based on different engineered versions of the B2 protein, wherein B2:mScarlet is used for coating/capturing of the dsRNA, and revealing is achieved by B2:ALP (B2 alkaline phosphatase) or B2:NLuc (B2 Nano-luciferase), reaching a LoD ~1.2 ng/mL and LoQ ~4 ng/mL for viral dsRNA with negligeable interference from ssRNA or DNA. DPS-B2Assay is validated in virus-infected (Tomato bushy stunt virus and Grapevine fanleaf virus) plant samples, and a proof-of-concept experimental pipeline is designed further to integrate dsRNA sensing with Oxford nanopore direct RNA sequencing[8] strategy (**dsNanoSeq**). Overall, positive samples from the DPS-B2Assay can be directly extracted and subjected to dsNanoSeq for quantitative analysis of dsRNA and viral species identification via reference database mapping, making it one of the very first dsRNA-based virus monitoring platforms, especially useful for EIDs (unknown pathogenic threat).



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Topics

Bioreceptors

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Abstract Title:

Computational Design of Peptide-Based Recognition Elements for Selective miRNA Detection

Abstract body:

MicroRNAs (miRNAs) are promising early cancer biomarkers due to their disease-specific expression, stability in biofluids, and compatibility with minimally invasive liquid biopsies [1]. However, their short, highly similar sequences variable base composition, and their complex secondary structures hinder specific and reliable detection [2]. In response to these challenges, we are developing a computational approach for designing peptide-based recognition elements that mimic natural RNA–protein binding interactions, aiming to identify key peptide motifs that can serve for specific miRNAs biosensors.

In this contribution, we present the potential of rationally designed peptides as synthetic recognition elements for miRNA. A peptide library was constructed using four rationally designed residue sets: **Library A**, comprising aromatic and basic residues to promote π–π stacking and electrostatic interactions; **Library B**, combining basic and acidic residues to evaluate charge-mediated binding dynamics; **Library C**, incorporating geometrically aligned residues to enhance surface complementarity through coplanar configurations; and **Library D**, featuring amino acids derived from RNA-binding protein (RBP) active sites to mimic natural recognition mechanisms. Docking studies against miR-21 identified two top-performing peptides, **D9** (−12.068 kcal/mol) and **A6** (−12.147 kcal/mol), with strong binding affinities. Molecular dynamics simulations further confirmed the stability and specificity of these peptide–miR-21 complexes. Detailed analyses of hydrogen bonding patterns, contact frequency, and selectivity against homologous miRNA sequences demonstrated high sequence specificity.

Following the computational analysis, the top-binding peptides (D9 and A6) will be employed to fabricate biosensors for selective and sensitive miRNA-21 detection in biological samples, while the lowest-affinity peptide will serve as a negative control to assess the binding specificity. This work outlines a powerful

strategy for developing next-generation peptide-based biosensors with strong potential to advance early and reliable cancer diagnostics.

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Topics

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5th European Biosensor Symposium

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Abstract Title:

Custom Antibody Service (CAbS-Nb4D) Engineering immunoreagents for high performance biosensors.

Abstract body:

The Custom Antibody Service (CAbS-Nb4D-CSIC) is a service established under the umbrella of the Institute of Advanced Chemistry of Catalonia (IQAC-CSIC) and the Biomedical Network Research Center in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN). CAbS is one of the units of the NANBIOSIS ICTS (Unit 2) and operates under an ISO 9001:2015-certified quality management system. We provide solutions for antibody projects in collaboration with national and international companies, research institutions, and universities.

CAbS services include personalized scientific advice, hapten design and synthesis, immunoreagent bioconjugation (enzymes, fluorophores, nanoparticles, etc.), polyclonal and monoclonal antibody development, antibody fragment production, and scale-up of antibody production and purification.

Antibodies are tailored for optimal biosensor performance, focusing on specificity, affinity, and conjugation strategies to enhance sensitivity, enable multiplexing, and reduce background interference.

Our specialized expertise in low molecular weight targets (e.g., hormones, pigments) ensures the generation of immunoreagents suited for environmental, food safety, diagnostic, biomarker discovery, and immunotherapeutic biosensing applications. By collaborating with CAbS, researchers and developers benefit from highly customized immunoreagents suited to their applications, ensuring performance, reproducibility, and regulatory compliance.

Abstract References

no references

Topics

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Abstract Title:

Data-Fused Thermal and Impedance Sensing for Monitoring of Cell Count and Culture Medium

Abstract body:

Understanding the interactions between cells and their surrounding medium is critical for optimizing cell culture processes. Culture medium composition directly reflects cellular metabolism, nutrient consumption, and stress responses, making it a valuable source of dynamic process information. However, traditional monitoring techniques are often invasive, destructive, or limited to end-point measurements. We present an integrated sensing platform based on thermal and impedance read-outs embedded in a microplate format. Previously proven effective for concurrent viability and cell count analysis, the system is now extended to assess medium composition. This dual read-out enables real-time, non-invasive analysis of culture dynamics.

The platform was calibrated using suspensions with varying cell and NaCl concentrations. The combined thermal and impedance datasets revealed distinct patterns. New conditions were predicted using inverse distance weighting. Sensor responses were interpreted in relation to cell count and medium conductivity across a multi-well microplate format.

Thermal readout correlated strongly with cell count, while impedance data reflected changes in both cell number and ionic strength of the medium. Combined, these signals produced distinct patterns enabling the simultaneous estimation of both parameters. Predictive models based on data fusion outperformed single-sensor approaches. This dual-parameter monitoring approach facilitates an understanding of cell-medium interactions and enhances the ability to track process variability in real time.

Simultaneous monitoring of cell count and medium composition provides insight into culture performance. Integrating thermal and impedance sensing offers a label-free, real-time solution for culture monitoring. This

approach might enable improved process control and detection of shifts in cellular behavior and medium quality.

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Goossens, J., Oudebrouckx, G., Vandenryt, T., & Thoelen, R. (2025). Microplate-based impedance and thermal sensing system for concurrent cell viability and counting analysis. Talanta, 295, 128193. Vis, M. A., Ito, K., & Hofmann, S. (2020). Impact of culture medium on cellular interactions in in vitro co-culture systems. Frontiers in bioengineering and biotechnology, 8, 911. Kress, J., Nandita, E., Jones, E., Sanou, M., Higgins, J., & Kosanam, H. (2023). A targeted liquid chromatography mass spectrometry method for routine monitoring of cell culture media components for bioprocess development. Journal of Chromatography A, 1706, 464281.

Topics

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5th European Biosensor Symposium

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Abstract Title:

Detection of autoinducing peptides for the diagnosis Staphylococcus aureus infections

Abstract body:

Background

Staphylococcus aureus is responsible for a wide spectrum of infections worldwide. Its virulence is modulated by the *agr* quorum sensing system, which is responsible of the production of four types of cyclic thiolactone autoinducing peptides (AIPs 1-4). The preceding results obtained by the group led to the identification of a previously not-described molecular form of the AIPs, consisting of a linear structure of the peptide. The aim of this work is the production of antibodies against linear AIPs and the development of immunochemical assays to detect the total amount of AIPs, both closed (AIPc) and open (AIPo).

Methods

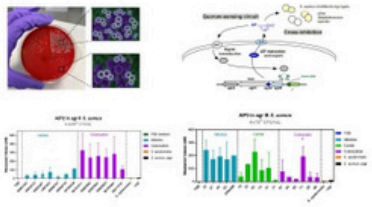
Haptens mimicking linear AIPs 1-4 were synthetized and conjugated to proteins used as immunogen or as ELISA reagent. Monoclonal and polyclonal antibodies were produced for the development of specific competitive indirect ELISAs of 1h 30min. The assays were characterized in terms of assay detectability, specificity, accuracy, reproducibility, precision and robustness.

Results

The developed conjugation method was successful for the immunization and production of antibodies. The ELISAs developed showed a LOD in the nanomolar range, being 6.926 ± 3.338 nM for AIP2o assay and 7.161 ± 3.98 nM for AIP3o assay. The cross-reactivity with other AIPs was <0.05%. *S. aureus* bacterial isolates obtained from human respiratory tracts were grown in TSB media during 24h. AIP2 and AIP3 were detected in bacterial cultures of agr II and III isolates, respectively, while no presence of AIP was detected in negative control strains, bringing to light the specificity of this diagnostic method.

Conclusions

The ELISAs developed revealed the potential of linear AIPs as biomarkers of *S. aureus* infections, which can be implemented in rapid and reliable diagnosis in point-of-care devices. The applicability of this method in biological samples, will noticeably ameliorate the management and treatment of the disease, thus improving clinical outcomes.



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Tong, S. Y. C., Davis, J. S., Eichenberger, E., Holland, T. L., & Fowler, V. G. (2015). Staphylococcus aureus Infections: Epidemiology, Pathophysiology, Clinical Manifestations, and Management. Salam AM, Quave CL. (2018). Targeting Virulence in Staphylococcus aureus by Chemical Inhibition of the Accessory Gene Regulator System In Vivo. Camilla V, Trespidi G, Chiarelli LR, Barbieri G, Buroni S. (2019). Quorum Sensing as Antivirulence Target in Cystic Fibrosis Pathogens. Wang, B., & Muir, T. W. (2016) Regulation of Virulence in Staphylococcus aureus: Molecular Mechanisms and Remaining Puzzles. Montagut, E. J., et al. (2022). "Direct Quantitative Immunochemical Analysis of Autoinducer Peptide IV for Diagnosing and Stratifying Staphylococcus aureus Infections." ACS Infect Dis 8(3): 645-656.

Topics

Bioreceptors

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5th European Biosensor Symposium

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Abstract Title:

Development of antibodies against mycotoxins and their application and validation in immunochemical methods

Abstract body:

Food safety is a central and topical issue in our society and is governed by food law.
Mycotoxins are secondary metabolic products formed by molds. These contaminants can enter food and thus the food chain through infestation, posing a serious health risk to humans and animals. For this reason, the European Commission has issued Regulation (EU) 2023/915, which sets maximum levels for certain mycotoxins in food. Currently, around 25 % of foodstuffs are contaminated with mycotoxins above the legally prescribed limits [1]. Regular checks are essential to prevent such exceedances.

The analytical methods currently available, mainly based on chromatographic techniques such as LC-MS/MS, are considered inadequate for on-site use – i.e., at processing and production facilities in the food industry – because they are technically complex and labor-intensive. One possible improvement is the use of immunoassays, which are widely accepted and employed in medical diagnostics. However, a basic prerequisite for developing such assays is the availability of specific antibodies.

Our focus in this project is the development of high-affinity, highly selective monoclonal antibodies against mycotoxins for which either no antibodies, only polyclonal antibodies, or antibodies with insufficient specificity are currently available. The goal is to generate antibodies targeting patulin, Alternaria toxins, and ergot alkaloids for use in rapid tests and on-site analytical systems. A key aspect is the group selectivity of the antibodies with regard to the various ergot alkaloids. Depending on the mycotoxin, heterologous or homologous haptens are used to immunize mice. To ensure monoclonality, we apply limiting dilution and antigen-specific fluorescence-activated cell sorting (FACS) during the selection process.

The antibodies developed will be used to expand SAFIA Technologies GmbH's existing mycotoxin test-kit, enabling reliable detection of mycotoxins in food and thereby contributing to improved food safety standards.

We will showcase our approach along with the results achieved so far.

Abstract References

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Topics

Bioreceptors

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Abstract Title:

Development of Molecularly Imprinted Polymers as an Indirect Sensing Approach for Spore-Forming Bacteria Detection

Abstract body:

Background

The presence of heat-resistant bacterial spores, such as those from *Bacillus cereus*, poses significant challenges to food safety. Dipicolinic acid (DPA) is a component of bacterial spores, constituting approximately 10 % of their dry weight, and it is a key factor in the resistance of spores to wet heat exposure [1-2]. Molecularly Imprinted Polymers (MIPs) offer a stable, easy to prepare, selective alternative for detecting small molecules such as DPA [3]. Here, we report the synthesis of MIPs targeting DPA for application in the indirect detection of spore-forming bacteria.

Methods and Results

MIPs were synthesized using (3-acrylamidopropyl)trimethylammonium chloride, ethylene glycol dimethacrylate, and azobisisobutyronitrile in a 1:1 dimethyl sulfoxide methanol system at 60 °C. The functional monomer was chosen for its permanent positive charge, which enhances electrostatic interactions with DPA. Triethylamine was added to promote deprotonation of DPA during polymerization. After Soxhlet extraction and acidified ethanol washings, binding performance was evaluated through rebinding tests in aqueous DPA solutions (0.2–0.7 mM). MIPs showed higher binding than non-imprinted polymers, with an average imprinting factor of 2.49. This approach could contribute to the development of rapid biosensors for detecting heat-resistant bacterial spores in liquid foods. Future work will apply the Heat Transfer Method (HTM) to broaden sensing applications.

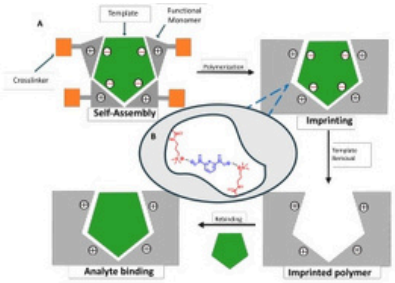

Figure 1: *A) Representation of MIPs synthesis and DPA rebinding. B) Potential interactions between the monomer (red) and the template (blue).*

Conclusions

The developed MIPs show promising selectivity towards DPA, indicating their potential for indirect detection of bacterial spores in food matrices. These polymers could form the basis of fast, resource-efficient sensors for early contamination detection.

Acknowledgements

The authors gratefully acknowledge funding and support from the SenSpores project, the Niederrhein University of Applied Sciences, Maastricht University, Ruhr University Bochum, and industrial partners in the food technology sector.

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Topics

Bioreceptors

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Abstract Title:

Dual Enzyme-Based Colorimetric Biosensor Using Tomato-Derived Peroxidase and Polyphenol Oxidase for Early Spoilage Detection

Abstract body:

Abstract:

Background:
Detecting fruit spoilage early is essential for reducing losses after harvest and ensuring food safety. Enzymes like peroxidase (POD) and polyphenol oxidase (PPO) are important indicators of fruit ripening and decay. These enzymes drive reactions that cause browning and oxidative damage, which are often seen during spoilage in fresh produce. Using their activity in a biosensing system presents a promising way to monitor quality in real time.

Materials & Methods:
We extracted POD and PPO from fresh tomatoes using a cold phosphate buffer. This was followed by centrifugation and partial purification. We carried out activity tests using spectrophotometry, with guaiacol for POD and catechol for PPO.

Results:
Both enzymes kept their activity after extraction and purification. The color change was quick and visible to the naked eye. The biosensor strip, made by immobilizing the enzymes on a cellulose matrix, showed clear browning when exposed to oxidizing agents linked to spoilage. Controlled trials demonstrated a relationship between color intensity and enzyme activity levels, confirming its sensitivity. The sensor's response to early spoilage makes it suitable for real-time monitoring during transport and storage.

Conclusions:
The dual enzyme-based biosensor strip is a cost-effective, sustainable, and quick tool for monitoring oxidative

spoilage in tomatoes. Its visible color change offers an easy way for non-specialists to check freshness, supporting efforts to reduce food waste and improve quality control in the supply chain.

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Topics

Bioreceptors

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Encapsulation of bacterial GMOs for a whole-cell-based optical and electrochemical sensor targeting environmental water pollutants

Abstract body:

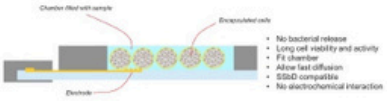
Environmental pollution poses a major threat to health and biodiversity. Aligned with the European Union's programme ZERO-POLLUTION, the BioSensei project addresses this challenge through a real-time, multiplexed, end-to-end, on-site optical and electrochemical monitoring system. Using cellular responses, this hybrid biosensor targets biotic and abiotic pollutants in water (i.e., nitrates, phosphates, endocrine disruptive chemicals, PFAS, and toxins).

To this purpose, immobilisation of genetically engineered bacterial cells on the transducer surface is required. Moreover, this project follows a Safe-and-Sustainable-by-Design (SSbD) framework, necessitating rigorous risk assessments, thus preventing environmental release of modified bacteria. Additional constraints include maintaining a metabolic activity for ideally a month, avoiding optical or electrochemical interference, and ensuring rapid diffusion of analytes from the environment to the bacteria and then to the transducers.

In that regard, various biocompatible polymers were tested to confine a model whole-cell sensor (*P. putida* with a rhamnose-induced Green Fluorescent Protein production). The selected method is layer-by-layer encapsulation of cells in alginate microbeads, coated with poly-L-lysine (PLL). This approach minimises capsule swelling and bacterial release while maintaining cell viability, as demonstrated by Laser Scanning Confocal Microscopy.
Cryo-Scanning Electron Microscopy images of encapsulated cells revealed a uniform bacterial distribution inside and on the capsule surface. The sensing activity of the model cells in single use, measured using fluorescent scanning spectroscopy, retained 84% one week after encapsulation and storage at room temperature, and 37% three weeks after, compared to the activity on the day of encapsulation. Experiments also confirmed that the PLL layer does not impede diffusion of analytes or pollutants. Strategies are evaluated

to enhance performance of immobilised cells in a reusable fashion, including sample preparation, cell load or oxygen supplementation in the sensor chamber.

Finally, integration of cell-loaded capsules onto electrochemical sensor interface is underway, with strategies being explored to enhance compatibility at the transducer surface.



Abstract References

None

Topics

Bioreceptors

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5th European Biosensor Symposium

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Abstract Title:

Engineering an Aptamer-based Au@Cu Sensor for Ultra-Sensitive Detection of Diazinon

Abstract body:

Pesticide residues, particularly those from organophosphorus compounds, pose a significant risk to both environmental and public health. Current analytical techniques suffer from several disadvantages, including high costs, lengthy analysis times, and the requirement for complex instrumentation[1]. Aptamers are synthetic single-stranded DNA or RNA oligonucleotides that bind to target analytes with high affinity and specificity. Owing to their conformational changes upon target binding and numerous other advantages, the application areas of aptasensors have been rapidly expanding [2]. The sensor design involved the aptamer on the surface of an electrode modified with Au@Cu bimetallic nanomaterials. During optimization of the sensor platform, precursor solutions with different molar ratios of Au:Cu, the optimal drop-casting volume and concentrations were determined using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). After rinsing and drying the modified electrode surface, 5 µM aptamer solution was drop-cast onto the surface and incubated at +4°C for 3 hours. Following incubation, the surface was washed with Tris-HCl buffer, and non-specific binding was blocked using 1% BSA for 30 minutes. After optimizing the electrode modification parameters, the influence of aptamer immobilization time on the sensor's electrochemical performance was systematically assessed through CV, differential pulse voltammetry, and EIS. The aptasensor exhibited optimal performance at 5 µM. Furthermore, the interaction time between the aptamer and Diazinon was evaluated at 15, 30, 45, 60, and 120 minutes, with 30 minutes identified as the optimal binding duration. Increasing concentrations of Diazinon were then applied to the aptamer-modified surface, followed by a 30-minute incubation. After this step, the calibration curve obtained within the concentration range of 32.8 pM to 16.4 nM showed a wide liner range, with the limit of detection and limit of quantification values as 10.82 pM and 32.8 pM, respectively, demonstrating the sensor's sensitivity. Application studies conducted in tap water samples.

Abstract References

1. Tanimoto de Albuquerque YD, Ferreira LF (2007) Amperometric biosensing of carbamate and organophosphate pesticides utilizing screen-printed tyrosinase-modified electrodes. Anal Chim Acta 596:210-221. https://doi.org/10.1016/J.ACA.2007.06.013 2. Hua Y, Ma J, Li D, Wang R (2022) DNA-Based Biosensors for the Biochemical Analysis: A Review. Biosensors 12:183. https://doi.org/10.3390/bios12030183

Topics

Bioreceptors

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5th European Biosensor Symposium

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Abstract Title:

Exploring hairpin oligonucleotides probes for triplex formation biosensing

Abstract body:

DNA biosensors based on nucleic acid recognition processes are being developed to enable rapid and simple testing of genetic and infectious diseases. Triplex-forming DNA probes have attracted increasing attention due to their ability to form triplexes by associating three nucleic acid strands. In addition, parallel and antiparallel hairpin probes markedly enhance detection using the triplex configuration compared with the conventional duplex approach. These specialized probes have been successfully used to detect DNA and RNA pyrimidine sequences involved in various diseases, as well as in the identification of multiple pathogens in the nanomolar range [1].

Following the excellent results obtained in the detection of Pneumocystis jirovecii, using two different biosensors [2,3], we developed a more accurate strategy called the triplex enhanced nucleic acid detection assay (TENADA) for SARS-CoV-2 virus detection. This strategy is based on a sandwich oligonucleotide hybridization approach. Efficient capture hairpin oligonucleotide probes are designed to form high-affinity triplexes with three distinct polypyrimidine target sequences within the viral genome. A second labelled oligonucleotide is then used to detect the formation of a trimolecular complex, in a similar manner to antigen tests. The limit of detection achieved is around 0.01nM, without the use of any amplification step, and the assay has been adapted for use with several biosensing devices, including thermal, lateral flow, electrochemical and fluorescent microarray devices [4].

Finally, we conducted a biophysical study using the TENADA approach to evaluate the key parameters of antiparallel hairpins that form triplex structures. These parameters include length, GC content, and the number and position of interruptions, all of which are important for ensuring effective targeting [5]. Additionally, we improved our designs using modified triplex-forming bis-pyrimidine clamps that target a polypurine sequence of SARS-CoV-2 [6]. These studies have broadened our knowledge of hairpin probes for effective biosensing purposes.

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Topics

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5th European Biosensor Symposium

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Abstract Title:

Fully synthetically fabricated biomimetic surface-MIPs for rapid whole bacteria detection

Abstract body:

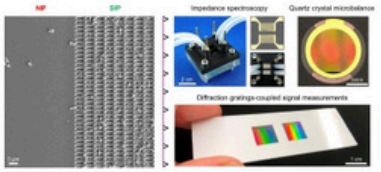
Antibiotic-resistant bacteria represent a significant challenge in healthcare, food industry and environmental monitoring. Addressing this threat requires the development of advanced solutions such as diagnostic and monitoring tools. Among these, biosensors employing imprinted polymers as a receptor layer such as molecularly imprinted polymers (MIPs) and surface imprinted polymers (SIPs) for direct bacterial detection are particularly attractive due to their robustness, cost-effectiveness, and long shelf-life. However, conventional fabrication methods of MIPs/SIPs depend on the usage of fresh template bacteria as a template and often result in low, non-tunable imprint density and distribution [1].

In this study, we present a novel "template bacteria-free" strategy to fabricate SIP-based biosensors for the detection of *Escherichia coli* as a model organism. This strategy uses direct laser writing lithography and soft lithography to create a master mold and PDMS-based positive stamp, respectively, featuring *E. coli*-like protrusions complementary to the shape of the bacteria. The stamp was subsequently functionalized with *E. coli*-specific lipopolysaccharides to enhance chemical recognition.

Using the developed stamp, SIP layers with a high density of biomimetic imprints (3×10^7 cavities/cm²) without using real template bacteria were achieved. By comparing *E. coli* capturing ability of NIP (non-imprinted polymer) and SIP, an imprinting factor of about 6.5 was found after 15 minutes of *E. coli* exposure. SIPs were then formed on various transducers such as interdigitated electrodes, quartz crystal microbalance chips, and reflective diffraction gratings; bacteria detection was demonstrated using different readout mechanisms such as impedance spectroscopy, quartz crystal microbalance with dissipation monitoring, and optical diffraction grating-based signal measurements (see graphical abstract).

The findings represent a new opportunity for direct bacterial detection using a SIP-based biosensor, whose fabrication method is versatile and easily adjustable and, more importantly, does not require the use of

template bacteria.



Abstract References

1. Ozsoylu, D., et al., Template bacteria-free fabrication of surface imprinted polymer-based biosensor for E. coli detection using photolithographic mimics: Hacking bacterial adhesion. Biosensors & Bioelectronics 2024, 261, 116491. DOI: 10.1016/j.bios.2024.116491.

Topics

Bioreceptors

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Improving Nanobody Stability and Production by Using ProteinMPNN

Abstract body:

Nanobodies offer unique advantages due to their compact size, monomeric structure, and ability to bind challenging epitopes. These characteristics make them ideal for developing sensitive and specific detection platforms, capable of identifying a wide range of targets [1]. An example of this is the development of several types of diagnostic tests that use nanobodies to detect conditions ranging from cancer and viral diseases to contaminants such as pesticides. However, challenges like low production yield and aggregation during expression limit their widespread use [2].

To address these limitations, we have developed a computational and artificial intelligence-driven engineering strategy to enhance the biophysical properties of nanobodies, focusing on their stability, solubility, and production yield. In particular, we use ProteinMPNN to optimize the conserved scaffold region of nanobodies. By targeting this highly conserved region, we preserve binding while maximizing the generalizability of our approach to different nanobodies.

We have tested this strategy on four nanobodies targeting clinically relevant molecules: tumor necrosis factor alpha, methotrexate, pancreatic amylase, and chorionic gonadotropin. After optimization, all engineered nanobodies show significant improvements in thermostability, expression and purification yield. Importantly, these modifications do not compromise their antigen-binding properties, validating the effectiveness of our design approach. Our findings also reveal consistent amino acid substitutions across different nanobodies, providing a transferable set of design principles for further optimization efforts.

This study highlights the potential of AI-driven protein engineering to address limitations of nanobody-based platforms, facilitating their implementation in biosensing applications. Furthermore, the generalizable nature of our strategy simplifies the adaptation of these improvements to other nanobody targets, paving the way for more diverse detection of molecules.

Abstract References
[1] S. Muyldermans et al., Annual Review of Animal Biosciences (2021) 9:401-421 [2] G Dingus et al., Elife (2022) 11:e68253

Topics

Bioreceptors

Pejenaute, Alba; Gálvez-Larrosa, Laura; Segovia, Cristina; Herrero-Alfonso, Pablo; Fernández-Ramos, David; Lopitz-Otsoa, Fernando; Millet, Óscar; Peccati, Francesca; Jiménez-Osés, Gónzalo; Ortega-Quintanilla, Gabriel
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POSTER

5th European Biosensor Symposium

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Abstract Title:

Molecular Biosensors for Neuroimmune Crosstalk: SWCNT-Based Catecholamine Detection in Real Time

Abstract body:

Neurotransmitters are released by different cell types to exchange information. Resolving their spatiotemporal patterns is crucial to understand chemical neurotransmission and diagnose diseases. We present nanosensors for neurotransmitters based on single-walled carbon nanotubes (SWCNTs), which fluoresce in the near infrared (NIR) tissue transparency window with ultra-low background and phototoxicity. The SWCNTs are biofunctionalized with specific DNA sequences, which makes them highly selective sensors of catecholamine neurotransmitters such as dopamine (1,2). They are sensitive in the nM range and can be used for imaging on the millisecond timescale, thus providing spatially and temporally resolved movies of neurotransmitter dynamics in live-cell environments (1,3).

We additionally apply these nanosensors to study how human immune cells (neutrophilic granulocytes) rapidly take up and package catecholamine neurotransmitters such as dopamine or epinephrine into MPO/VMAT2-positive primary vesicles, using the machinery previously identified in neurons (4). With these sensors we show that serotonin or activated platelets trigger calcium (Ca2+) signaling and subsequent fast and transient release of catecholamines from neutrophils, which we are able to directly observe using (GT)10-DNA functionalized SWCNTs. Catecholamines reduce NET-formation but increase platelet aggregation. Thus, we establish similarities between neurons and neutrophils and identify a paracrine neutrophil-platelet feedback loop relevant to inflammation and coagulation. These findings show the huge potential of nanosensors to release fast and dynamic signaling between cells.

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Topics

Bioreceptors

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5th European Biosensor Symposium

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Abstract Title:

Monoclonal Antibody-Based Detection of Pseudomonas aeruginosa Quorum Sensing-Regulated Virulence Factors

Abstract body:

Background: Monoclonal antibodies (mAbs) have become powerful tools in diagnostics and therapeutics due to their high specificity for target antigens, making them ideal biorecognition elements in biosensor platforms. Their integration into diagnostic technologies enables rapid and selective detection of pathogenic microorganisms. Pseudomonas aeruginosa is a Gram negative, opportunistic pathogen known for multidrug resistance and is a leading cause of hospital-acquired infections. This bacterium relies on quorum sensing (QS) system to regulate virulence and biofilm formation. MAb-based biosensors provide a promising tool not only for rapid detection but also for monitoring therapeutic responses, enabling real-time assessment of infections and guiding personalized treatment strategies.

Methods: A QS-specific, high-affinity mAb against the virulence factor 2-Heptyl-4-Quinoline N-Oxide (HQNO) was generated using hybridoma technology. Following screening, the selected clones were expanded, the mAb was purified, and its binding characteristics were fully characterized using indirect ELISA assays.

Results: Our group previously developed a highly sensitive mAb targeting another virulence factor, pyocyanin (PYO). In this study, we successfully generated a mAb against HQNO, achieving a limit of detection (LOD) of 0.46 nM, demonstrating high assay sensitivity. Using these antibodies, we monitored the growth of P. aeruginosa by quantifying PYO and HQNO levels over a 50- hour period. Both metabolites showed a progressive increase over time, with no detectable levels observed during the first 7 hours. From hour 8 onward, concentrations of both compounds began to rise, with PYO reaching 6,753 nM and HQNO significantly exceeding it, reaching 45,015 nM at 50 hour.

Conclusions:This comparative analysis underscores the potential of HQNO and PYO as valuable biomarkers for P. aeruginosa infection and predictive monitoring. Our findings lay the groundwork for the future integration of the developed antibodies into biosensor platforms for real-time, highly sensitive detection, with applications in diagnostics, therapeutic monitoring, and environmental surveillance.

Abstract References

Rodriguez-Urretavizcaya, B., Pascual, N., Pastells, C., Martin-Gomez, M. T., Vilaplana, L., & Marco, M. P. (2021). Diagnosis and Stratification of Pseudomonas aeruginosa Infected Patients by Immunochemical Quantitative Determination of Pyocyanin From Clinical Bacterial Isolates. Frontiers in cellular and infection microbiology, 11, 786929. https://doi.org/10.3389/fcimb.2021.786929 Montagut, E. J., Raya, J., Martin-Gomez, M. T., Vilaplana, L., Rodriguez-Urretavizcaya, B., & Marco, M. P. (2022). An Immunochemical Approach to Detect the Quorum Sensing-Regulated Virulence Factor 2-Heptyl-4-Quinoline N-Oxide (HQNO) Produced by Pseudomonas aeruginosa Clinical Isolates. Microbiology spectrum, 10(4), e0107321. https://doi.org/10.1128/spectrum.01073-21

Topics

Bioreceptors

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ORAL COMMUNICATION

5th European Biosensor Symposium

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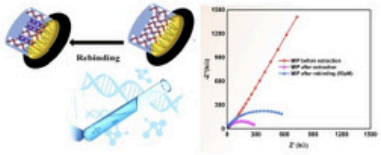
Abstract Title:

Multimodal Recognition Architectures for microRNA Biosensing

Abstract body:

MicroRNAs (miRNAs) are an important class of small non-coding RNAs, typically about 18–26 nucleotides in length. They are dysregulated in a wide range of pathological conditions, including cardiovascular diseases, neurodegenerative disorders, and various cancers [1]. Despite their clinical significance as diagnostic and prognostic biomarkers, their detection e.g., in cancer diagnostics is challenging due to their small size, low abundance, and high sequence similarity, which complicates their sensitive and selective detection. Methods such as real-time quantitative reverse transcription PCR (qRT-PCR), which are widely used, are limited for these short miRNAs, as a direct amplification is prevented, requiring additional steps such as polyadenylation or stem-loop priming [2]. In contrast, biosensors based on synthetic recognition elements such as molecularly imprinted polymers have gained importance in detecting biomedically relevant markers including miRNAs [3].



In this contribution, we present a hybrid electrochemical biosensor that combines molecularly imprinted polymers (MIPs) and peptide nucleic acids (PNAs) for the selective detection of miRNA. MIPs were synthesized by electropolymerization using PNA-supported and pre-oriented miR-21 templates molecules. MIPs offer a robust, tailorable matrix capable of selectively rebinding miRNAs through the imprinted effect, whereas PNAs provide strong hybridization affinity due to their neutral backbone and enhanced sequence specificity [4]. After optimizing the experimental parameters, electrochemical impedance spectroscopy (EIS), a sensitive electrochemical technique, was employed to detect miR-21. Analytical figures of merit were determined achieving a limit of detection (LoD) of 0.11 ± 0.04 pM without any amplification steps. To

demonstrate the feasibility of the developed sensor, next to artificial serum as a model sample, miR-21 was determined in RNA isolates of MCF-7 and Hela cells. This approach opens up new avenues for the application of MIPs as synthetic antibodies in miRNA research and highlights the importance MIP-based sensors. An outlook towards bioengineered peptides for miRNA will also be

Abstract References

[1] D. Bautista-Sánchez, et al., Mol. Ther. Nucleic Acids 20 409–420 (2020). [2] T. Jet, G. Gines, Y. Rondelez, V. Taly, Chem. Soc. Rev. 50 4141–4161 (2021). [3] L. Wu, X. Li, H. Miao, J. Xu, G. Pan, View, 3, 20200170 (2022). [4] M. Abdel-Hamied, M. Guo, Y. Wei, J. Bansmann, R.M. El Nashar, F. Oswald, B. Mizaikoff, C. Kranz, Bioelectrochemistry 165 108964, (2025).

Topics

Bioreceptors

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5th European Biosensor Symposium

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Abstract Title:

Novel Monoclonal Antibody for Coenzyme Q10: A diagnostic tool for mitochondrial OXPHOS diseases

Abstract body:

Background

Coenzyme Q10 (CoQ) is a key electron carrier in mitochondrial oxidative phosphorylation (OXPHOS), and its deficiency—either primary or secondary—is commonly associated with OXPHOS disorders. Despite its diagnostic relevance, current detection methods rely on biochemical quantification from invasive samples and lack spatial or qualitative cellular information. CoQ is synthesized by all cell types and distributed in various membranes, yet little is known about its intracellular localization or redox status. The absence of antibodies imaging-based detection of CoQ in cells or tissues, limiting the study of its dynamics and tissue distribution, especially after therapeutic supplementation, and constraining its clinical and diagnostic exploration.

Methods

Monoclonal antibodies were generated by using a rationally designed CoQ-hapten immunogen. The isoprenoid tail of native CoQ10 is embedded in lipid membranes and only the benzoquinone head group is exposed, we synthesized a truncated CoQ analog with a shortened side chain to expose the reactive head group and improve epitope accessibility.

Results

We designed a CoQ10-based immunogen with a truncated side chain to expose the ubiquinone head group, enabling the generation of monoclonal antibodies targeting different molecular regions. Two types of clones were obtained: those recognizing the head group and others binding to the full CoQ molecule. Selected clones enabled immunohistochemical detection of endogenous CoQ in skeletal muscle, revealing deficiencies in patients with confirmed OXPHOS disorders. Clones specific to the ubiquinone ring detected CoQ in blood

at concentrations below 2 µM, the diagnostic workflows and the development of image-based biomarkers for OXPHOS disorders.

Conclusions

Monoclonal antibodies against CoQ10 enable cellular localization and quantification, enhancing mitochondrial disease diagnosis. They allow less invasive blood screening and early detection of deficiencies. These tools also facilitate studying CoQ10 dynamics and therapy uptake, supporting their integration into diagnostic workflows and the development of image-based biomarkers for OXPHOS disorders.

Abstract References

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Topics

Bioreceptors

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Polynorepinephrine-based molecularly imprinted nanoparticles: synthetic bioreceptors for reusable SPR-based protein detection

Abstract body:

A new class of molecularly imprinted biopolymers based on polynorepinephrine (MIPNE) offers a promising antibody alternative for diagnostics and therapy. Formed via simple aqueous polymerization, MIPNE nanofilms and nanoparticles (MIPNE-NPs) enable selective recognition of target proteins through epitope imprinting (1,2). Upon template removal, stable 3D binding sites mimic natural antibodies. MIPNE-NPs show tunable size, high affinity, and were successfully integrated into SPR and BLI assays (3), here for IgG detection as a model study. Additionally, polynorepinephrine exhibits reducing and metal-chelating properties, allowing in-situ formation of metallic nanostructures. These features support MIPNE materials as versatile tools for biosensing, drug delivery, and nanofabrication applications.

MIPNE-NPs were synthesized via multivariate optimization to correlate synthesis parameters with particle morphology. Key variables such as temperature, time, buffer, pH, agitation, monomer, and epitope (441-KSLSLSPGK-449) concentration were systematically explored. Optimized NPs were integrated into SPR assays using covalent and non-covalent immobilization. Flow-assisted adsorption on bare gold proved highly effective, enabling strong analytical performance, easy regeneration with NaOCl, and reproducible signals. MIPNE-NPs showed excellent specificity for both the imprinting epitope ($\alpha = 3.5$) and full IgG ($\alpha > 27.4$), confirming imprinting fidelity. Preliminary in vitro toxicity tests on keratinocytes confirmed biocompatibility. In parallel, nanostructured PNE films were fabricated by polymerizing NE in nanopatterned PDMS molds. These surfaces were then used to direct the in-situ growth of plasmonic nanoparticles, leveraging PNE's intrinsic metal-binding and reductive properties. This enabled fabrication of spatially controlled plasmonic architectures for advanced optical applications (4).

This research demonstrates the successful development of MIPNE-NPs as viable alternatives to antibodies for bioanalytical applications. The streamlined, regenerable workflow, combined with the high affinity of the NPs, positions MIPNE-NPs as a promising antibody-mimetic alternative in affinity-based assays. Their cost-effectiveness, robustness, and adaptability support potential applications not only in diagnostics, but also in targeted therapeutic delivery.

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Topics

Bioreceptors

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Rapid and Specific Detection of Whole-Cell Pathogens Using Phage Protein-Based Lateral Flow Assays

Abstract body:

Background

Foodborne pathogens like *Bacillus cereus* (B. cereus) represent a major threat to food safety. Conventional detection methods are time-consuming and costly, often unsuitable for rapid point-of-care diagnostics. Lateral flow assays (LFAs) based on gold nanoparticles (AuNPs) offer a rapid, low-cost alternative, but their reliance on antibodies raises issues of production complexity, ethical sourcing, and batch variability. In this study, we explore the use of bacteriophage-derived proteins as novel bioreceptors to overcome these limitations. Specifically, we investigate the binding performance of two recombinant proteins—the cell-wall-binding domain (CBD) of an endolysin and a distal tail protein (Dit)—that selectively recognize *B. cereus*.

Materials & Methods

CBD and Dit proteins were recombinantly produced and characterized for their binding affinity to *B. cereus*. Protein orientation on nitrocellulose and AuNPs was studied and optimized using sequence-based machine-learning (ML) predictions (AlfaFold). The biointerface properties were analyzed at micro- and nanoscale levels, including quantification of AuNP-bacteria binding via microscopy. Finally, the biointerface functionnality was studied by designing a single-step LFA for whole-cell *B. cereus* detection in aquous samples.

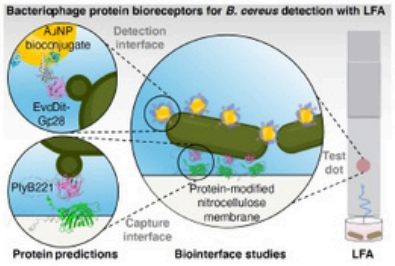
Results

The use of ML-guided protein orientation suggested binding performance. Microscopic analysis revealed that each *B. cereus* cell could bind up to 100 AuNPs under LFA-like conditions, confirming high capture efficiency. Both proteins exhibited strong and specific interactions with bacterial targets. A prototype LFA integrating

CBD and Dit enabled visual detection of 10^5 *B. cereus* cells within 15 minutes. These findings demonstrate the viability of phage proteins as robust and reproducible alternatives to antibodies in LFAs.

Conclusions

Bacteriophage-derived proteins are promising antibody-free bioreceptors for LFAs, enabling fast, specific, and ethical detection of *B. cereus*. Their recombinant production allows for scalable and customizable diagnostics. This approach advances rapid, low-cost pathogen detection technologies and reinforces tools for improved food safety and public health protection.



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Topics

Bioreceptors

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POSTER

5th European Biosensor Symposium

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Abstract Title:

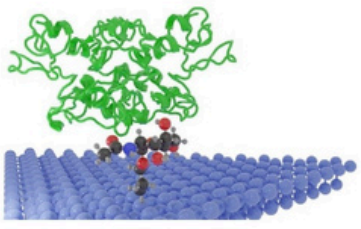
SnO2 layer for selective galectin detection

Abstract body:

Galectins play a crucial role in a range of biological processes, and their detection is essential for diagnosing diseases like cancer.[1] Current biosensors face challenges in specificity and portability. This work aims to develop electrical biosensors for specific galectins (primarily Galectin-1 and Galectin-3), whose concentrations are linked to the progression of brain tumors.[2] We utilize semiconductor SnO_2 layers as a sensitive material, as its conductivity changes upon protein binding.

My work is divided into two main parts. The first part involves characterizing the SnO_2 layer and addressing options for its passivation to optimize the material's electrical properties for biosensor applications. Simultaneously, we are focusing on reducing electrical noise and measurement instability, which is crucial for achieving reliable results. For characterization, we employ techniques such as atomic force microscopy (AFM), contact angle measurement (CA), spectroscopy, scanning electron microscopy (XSEM), X-ray diffraction (XRD), X-ray fluorescence (XRF), and especially IV characteristics measurements.

In the second part, we functionalize the surface using a molecular anchor and subsequently bind LacNAc to it. Following this, we bind specific galectins to the LacNAc and then elute them using a competitor, which allows us to study binding dynamics and optimize sensor selectivity.



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Topics

01 Bioreceptors -

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Abstract Title:

Spore-Imprinted Polypyrrole for Fusarium oxysporum Spore Detection

Abstract body:

Background

In the Netherlands, greenhouse cultivation spans 9,688 hectares and consumes approximately 106.8 petajoules of energy annually, with heating comprising 74% of this energy demand [1]. A primary driver of this energy use is the need to mitigate fungal infections, which consistently threaten crop productivity. To suppress fungal proliferation, greenhouses maintain low relative humidity through frequent heating and ventilation cycles [2]. Real-time monitoring of fungal spore concentrations is a promising approach to reduce the energy demand by enabling targeted climate control. Surface-imprinted polymers (SIPs) offer a stable, low-cost, and selective sensing approach suitable for harsh environments. This study introduces the development of a fungal spore sensor utilizing gold screen-printed electrodes functionalized with surface-imprinted polymers (SIPs).

Materials and Methods

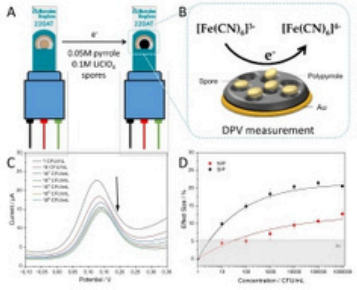
In this project, SIPs were synthesised by electropolymerisation of 0.05 M pyrrole in 0.1 M lithium perchlorate on Au electrodes within a potential window of 0 to 1 V (figure 1A). After template removal, the sensors were tested using differential pulse voltammetry (DPV) to assess dose response (figure 1B), selectivity, and performance in spiked greenhouse drainage water samples.

Results

The SIP-based sensors showed a clear, dose-dependent response to *F. oxysporum* spores over a concentration range of 1–10^6 CFU/mL, with significantly higher signal responses compared to non-imprinted controls (figure 1C and 1D). Selectivity testing showed mixed results, with partial discrimination between target and non-target fungi. When tested in greenhouse drainage water, the sensor retained its sensitivity after filtration and minimal sample preparation, confirming its suitability for complex environments.

Conclusion

This study demonstrates the feasibility of SIP-based electrochemical sensors for selective, in situ detection of F. oxysporum spores. The platform shows strong promise for integration into greenhouse monitoring systems, supporting more sustainable, energy-efficient crop protection. Future work will focus on multiplexed detection of multiple fungal pathogens.



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Topics

Bioreceptors

Philippaerts, Nathalie[1]; Peters, Erik[2]; Zanzen, Ulrike[3]; Huysmans, Marlies[4]; Bosmans, Lien[4]; Cleij, Thomas J.[1]; Dilliën, Hanne[1]; Eersels, Kasper[1]; Lowdon, Joseph W.[1]; van Grinsven, Bart[1]

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Targeting Soluble BCMA with DNA Aptamers: New Tools for Liquid Biopsy Diagnostics in Multiple Myeloma

Abstract body:

Multiple myeloma (MM) is an aggressive and currently incurable haematological malignancy. The B-cell maturation antigen (BCMA) has emerged as a promising biomarker for diagnostic and therapeutic applications (theranostics). BCMA is overexpressed on the surface of malignant plasma cells, and the recent identification of its soluble form (sBCMA) in the bloodstream offers new opportunities for liquid biopsy-based monitoring of disease progression and therapeutic response [1].

Aptamers, synthetic oligonucleotide-based ligands, represent an attractive alternative to antibodies due to their high thermal and chemical stability, batch-to-batch consistency, and lower production costs. While a single anti-BCMA RNA aptamer, designed for therapeutic use in combination with a microRNA, has been reported,[2] DNA aptamers, which are more stable in biological environments, are particularly well suited for diagnostic applications. However, DNA aptamers targeting sBCMA have not yet been described.

Here, we report on the selection of the first DNA aptamers specifically recognising sBCMA. Using a SELEX approach based on magnetic beads with oriented BCMA immobilisation, we identified five candidate sequences based on secondary structure and motif conservation. Their affinity and selectivity were characterised by electrochemical techniques and circular dichroism spectroscopy. Among them, the aptamers BCMA-23 and BCMA-24 showed the highest binding affinity and specificity. These aptamers were incorporated into sandwich assays for the clinical quantification of sBCMA. Electrochemical sensors utilizing these aptamers offer a promising platform for the sensitive and selective detection of protein biomarkers in serum, supporting the development of robust liquid biopsy tools for MM diagnostics.

Acknowledgements

This work has been financially supported by the Spanish Government (Project PID-2021-123183OB-I00) and Principado de Asturias (IDE/2024/000677). A. Díaz Fernández was supported by a senior postdoctoral contract from Instituto de Invetigación del Principado de Asturias (ISPA).

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Bioreceptors

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5th European Biosensor Symposium

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Abstract Title:

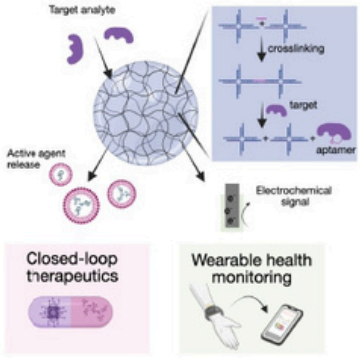
Toward Smart Biomaterials: Programmable DNA Hydrogel Microbeads

Abstract body:

Continuous health monitoring, early disease detection, and personalized, closed-loop therapeutics are shaping the future of medicine. While major progress has been made in wearable and point-of-care devices, few materials integrate molecular sensing, computation, and actuation within a single, programmable platform.

DNA-based hydrogels have previously been shown to support the integration of molecular sensors[1], logic gate operations[2], and responsive cargo release[3]. Their porous structure enables molecular diffusion[4] and facilitates exchange with the environment. We use emulsion-based droplet microfluidics to fabricate uniformly sized hydrogel microbeads (<100 µm), assembling synthetic hydrogel cells. These microbeads remain stable in mammalian cell culture and can be loaded with molecular cargo of different sizes, from fluorescent reporter strands to microspheres. We further demonstrate molecular communication between individual beads, enabled by DNA strand-displacement reactions.

Future work focuses on expanding the signal processing capacity within the hydrogels, interfacing with electronics, and exploring co-culture with biological systems. Ultimately, our goal is to engineer active systems capable of logic operations and feedback - laying the groundwork for synthetic tissues, diagnostic devices, and dynamic therapeutic interfaces.



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Topics

Bioreceptors

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Abstract Title:

Tree-free paper integrating laser-induced graphene third-generation biosensor for inulin determination in biological fluids

Abstract body:

Inulin is a naturally occurring fructan-type polymer recognized as 'gold standard' for estimating glomerular filtration rate (GFR). GFR is employed to monitor kidney functionality and is commonly assessed via complex instrumental methodologies. On the other hand, 3rd generation enzymatic sensors are based on the direct electron transfer (DET) phenomenon, which confers unique and captivating features for the development of electrochemical biosensors. Nevertheless, despite the encouraging strides obtained, the use of paper substrates for DET-based electro-analytical devices is still underexplored.

This work proposes a paper/graphene-based third-generation enzymatic sensor for inulin determination. Tree-free bamboo-derived paper (FB) was employed as a functional biosensor base, given its ability to accommodate both laser-induced graphene (LIG) as transducer film and Fructose Dehydrogenase (FDH) as bioreceptor.

FB-LIG electrochemical features were tested vs. office-grade paper and nitrocellulose, deepening direct-electron transfer electro-catalysis towards FDH, revealing the active role of the substrate. FB-LIG demonstrates the greatest bioelectro-catalytic ability and was integrated into a complete biosensor format, which was employed to determine inulin in human urine and serum. In-matrix calibration was employed to ensure a straightforward inulin determination in samples, obtaining useful dose-response linearity (urine: 1.6 – 22.7 mg L^{-1}; serum: 4.6 – 11.4 mg L^{-1}) and sensitivity (LOD: urine = 0.3 mg L^{-1}, serum = 1.0 mg L^{-1}), together with an impressive reproducibility (RSD ≤ 2.0%, n = 3). FB-LIG biosensors were exploited to determine inulin in real urine and serum samples at clinically relevant levels, obtaining satisfactory recoveries (90 – 111%; RSD ≤ 7.9%, n = 3).

Herein, for the first time, a sustainable substrate allowed the construction of a paper-based third-generation biosensor, shedding light on LIG on paper's potential for bioelectrocatalysis and realizing a smart tool for inulin determination in biological samples, potentially usable for GFR assessments.

Abstract References

Acknowledgements: The authors acknowledge financial support of MUR PRIN 2022 Project No. 2022T2E7NT_01, CUP C53D23003850006, under the National Recovery and Resilience Plan (NRRP), Mission 4 Component C2 Investment 1.1- MUR call No. 104 on 2 February 2022, funded by the European Union-NextGenerationEU.

Topics

Bioreceptors

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Use of engineered antibody fragments for electrochemical biosensing

Abstract body:

Engineered antibody fragments are sections of antibodies, in this case the Fab region, that have been modified with functional groups. These Fabs have the advantage of being smaller than full antibodies, thus more can be packed onto a biosensor's surface increasing the sensitivity of the biosensor [1]. Furthermore, the addition of functional groups (in this case azide and biotin) via a linker allows correct orientation of the Fabs on an electrode surface to further increase the sensitivity of the biosensor [2].

In this study, biotin and azide linkers were created and inserted into the Fabs between the heavy and light chains at the disulphide bridge. These modified Fab were immobilised onto evaporated gold electrodes and target detection was achieved via EIS. These biosensor surfaces were further investigated via QCM.

Three surfaces were investigated: 1) azide linkered Fab, 2) biotin linkered Fab and 3) azide Fab functionalised via amine groups. All sensors responded to the target in the range 20 – 400 nM. Comparison between 1 and 3 shows that the linkered antibody (1) produced a sensor with higher sensitivity. Comparison between 1 and 2 with EIS shows little difference in sensitivity, however QCM analysis demonstrates that surface 1 had a larger surface coverage of Fab and a larger reaction to the target at the concentration investigated.

In summary, functional groups were successfully added to Fabs and investigated for use in electrochemical biosensors. These Fabs were tested and compared using electrochemical sensing and QCM techniques and it was determined that the linkers provide a better sensitivity, likely due to oriented binding of the antibody fragment. Furthermore, the biosensor surface for the biotin linkered Fabs was found to provide a better sensitivity compared to that of the azide linkered Fabs.

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Topics

Bioreceptors

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DATA ANALYSIS

POSTER

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Abstract Title:

A Novel Electronic Tongue with Diverse Electropolymerized MIPs Sensors for Nonlinear Multi-Analyte Detection of Bisphenol A and S

Abstract body:

Bisphenol A (BPA) and its analogues, such as bisphenol S (BPS), are widely recognized endocrine-disrupting chemicals (EDCs) that pose significant threats to environment and human health. In this work, we developed an intelligent sensing platform based on electronic tongue (ET) for the simultaneous detection of BPA and BPS in mixed samples. The system incorporates two molecularly imprinted polymer (MIP) sensors, synthesized separately using pyrrole and m-phenylenediamine (MPDA) as functional monomers, to generate complementary electrochemical responses [1,2]. This could be easily shown through Principal Component Analysis. Notably, the sensor response in mixed solutions deviates from the linearity observed in single-component systems due to inter-analyte interference and nonlinear signal coupling. To address this, a multi-input multi-output artificial neural network (MIMO-ANN) was trained to model the complex response patterns and accurately predict the concentrations of both analytes. Experimental results demonstrate that the proposed MIPs-ET-ANN framework achieves high prediction accuracy and robustness, particularly at low concentration levels. This study highlights the potential of intelligent modeling in overcoming multi-analyte interference, offering a promising strategy for green sensing and environmental monitoring of EDC.

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Topics

Data analysis

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ORAL COMMUNICATION

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Abstract Title:

Dopamine Detection in the Presence of Interfering Substances Using Machine Learning Methods

Abstract body:

Dopamine (DA) is a neurotransmitter of central importance to many functions of the nervous system. Along with its metabolites and metabolic enzymes, DA determination is critical in the treatment of diseases related to the DA metabolism. Differential pulse voltammetry (DPV) is a quick and reliable method for DA detection. However, samples or analytic assays often contain substances that can interfere with signal generation even when they are not electro-active. One of these compounds represent magnesium ions that are essential for the activity of many enzymes.

In order to determine DA concentrations in the presence of varying (and unknown) amounts of Mg^{2+}, a large number of DPV measurements were recorded at fluorine-doped tin oxide (FTO) electrodes, using different DA and Mg^{2+}-concentrations. The influence of Mg^{2+} on the properties of the DA oxidation signal were elucidated and empirical calibration models were derived based on these findings.

Both DA- and Mg^{2+}-concentrations clearly displayed an influence on multiple shape parameters of the DPV-curves. By using a suitable mathematical framing and transformations of these DPV features, multiple linear regression models could successfully be applied to allow DA concentration analysis in unknown samples with an average relative error (6.8%) that is only slightly larger than the experimental error (5.5%). In order to demonstrate the practical applicability a simplified linear calibration procedure for DA in the presence of Mg^{2+} could also be derived and has demonstrated favourable performance (error of ~8.7%) while requiring only a small number of calibration measurements.

In summary, methods from machine learning and data analysis were successfully applied towards the determination of DA in the presence of Mg^{2+}, using a large dataset. The resulting model could be simplified to obtain a simple linear calibration procedure that compensates for the interference from Mg^{2+} while requiring fewer measurements for calibration.

Abstract References

original publication: C. Kallabis et. al. Bioelectrochemistry, 157 (2024), 108667. DOI: 10.1016/j.bioelechem.2024.108667

Topics

12 Data analysis -

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ELECTROCHEMICAL TRANSDUCERS

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5th European Biosensor Symposium

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Abstract Title:

3D-Printed Electrochemical Aptasensor for Label-Free Detection of Breast Cancer Cells

Abstract body:

Breast cancer is the most common type of cancer worldwide. It is the leading cause of death from cancer, especially among women. Breast cancer is highly heterogeneous. [1]. Treatment strategies for breast cancer vary based on molecular characteristics, including human epidermal growth factor 2 (HER2) activation, hormonal receptors, and gene mutations. However, the chances of successful cancer treatment are greatly increased by early diagnosis. Therefore, it is essential to detect cancer early by identifying cancer cells [2]. Triple negative breast cancer is a highly aggressive and poorly prognosed type that lacks the estrogen receptor (ER), progesterone receptor (PR) and human epidermal growth factor receptor 2 (HER2). Since ER, PR, and HER2 are not active, it does not respond to many treatment options [3,4]. The MDA-MB-231 cell line is a human breast adenocarcinoma model with high invasive and metastatic potential used in studies of triple-negative breast cancer [5].

In this study, an electrochemical aptasensor for the diagnosis of MDA-MB-231 triple negative breast cancer was developed. Disposable CB/PLA electrodes produced with 3D printing technology were used for the sensor surface. MDA-MB-231 breast cancer cell specific aptamer sequence was immobilized on the sensor surfaces. Aptamer and MDA-MB-231 target cell interaction was analyzed by Electrochemical Impedance Spectroscopy (EIS) technique. The selectivity of the biosensor was provided by the non-specific PSA (prostate cancer) cell. The aptasensor was optimized for higher specifity and sensitivity.

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Topics

Electrochemical transducers

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ORAL COMMUNICATION

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Abstract Title:

A label free electrochemical aptasensor enables the ultrasensitive and selective detection of neurofilament light.

Abstract body:

Plasma neurofilament light (NfL) has been identified as biomarker of Alzheimer's disease (AD), potentially playing a key role in the diagnosis of early-stage AD (Figure 1A) [1,2]. Its concentration is in very low levels in both healthy people and patients, which poses a challenge to its precise detection. In state-of-the-art clinical practice, the most widely used technology is the optical single molecule array (Simoa). However, its complex operation and high cost limit its applications. In addressing these challenges, we have identified and characterised novel aptamers that target NfL. For the identification of suitable aptamers, a ssDNA library was incubated with the NfL, and capillary electrophoresis of equilibrium mixtures SELEX (CE-SELEX) was used to isolate the aptamer-protein complex via several selection rounds with increasing selection pressure (Figure 1B). The binding affinity of the obtained aptamer candidates was determined by fluorescence polarisation. The sequence with the highest enrichment and a K_d of 78.73 nM was subsequently truncated and modified by a thiol-$(CH_2)_6$ group to meet the requirements of electrochemical sensor implementation. Later, the gate electrodes of organic electrochemical transistor (OECTs) were functionalized with the aptamer through gold-thiol bonds [3] and PEG was used as the blocker to avoid the biofouling. The transfer curves of the OECTS were recorded for different NfL concentrations (Figure 1C). An obvious potential shift (ΔV_G) was observed corresponding to different NfL concentrations resulting in a calibration curve with a sub-pM K_d value. Finally, the sensor's high-level performance was corroborated in complex samples by spiking NfL into human serum. Here, we report on a sensitive and selective aptasensor for NfL that aims to support the diagnosis of Alzheimer's disease through minimal invasive blood tests in the early stages of the disease even before cognitive impairment becomes noticeable in individuals' behaviour.

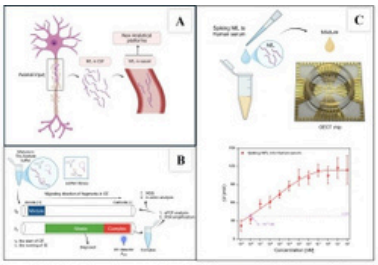

Figure 1: A) NfL release after axonal damage B) The process of NfL aptamer selection via capillary electrophoresis SELEX C) Top: NfL spiked into 10 times diluted human serum and measured by an OECT array chip. Bottom voltage drift response of the sensor to NfL.

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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

A Miniaturized Multi-sensor Chip for Small-Scale Bioreactor Monitoring in Precision Fermentation

Abstract body:

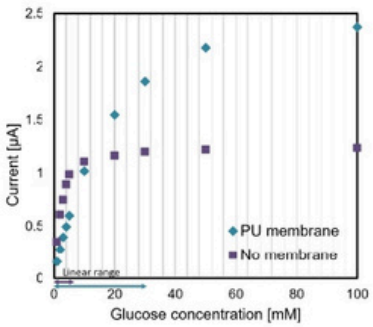
Precision fermentation is an advanced biotechnology that uses genetically engineered yeast cells to produce specific proteins, enzymes, or other biomolecules. By inserting genes encoding target compounds-such as dairy proteins, enzymes, or pharmaceuticals-into yeast, they can synthesize these products efficiently. This technology enables the sustainable production of food ingredients such as animal-free dairy [1], molecules of pharmaceutical interest [2], and agrochemicals [3] without animal or plant farming. Precise control of fermentation parameters such as glucose concentration, temperature, and pH is essential to ensure efficiency and quality. This creates a need for compact, low-cost multisensory chips for continuous monitoring in small-scale bioreactors, used in research.

A platinum microelectrode multi-sensor chip was fabricated on a 7 mm × 7 mm glass substrate by Pt patterning via photolithographic lift-off and parylene-C passivation with reactive ion etching. It features a nanostructured Pt electrode functionalized as enzymatic glucose sensor with on-chip reference and counter electrode, temperature sensor, conductivity sensor, and pH sensor. [4]

A wide operating range is crucial for glucose sensors, as fermentation glucose levels typically vary from 100 mM to trace amounts. To extend the linear range, the sensor was dip-coated with a glucose diffusion-limiting polyurethane (PU) membrane. Sensors with and without the PU membrane were calibrated by spiking glucose up to 100 mM in phosphate-buffered saline. Figure 1 shows the average current during chronoamperometry at 0.5 V across glucose concentrations. The dip-coated membrane improved the linear range ($r^2 > 0.95$) from 5 mM to 30 mM. The sensor was then tested in YPD, a complete yeast growth medium, exhibiting a linear range of 20 mM.

A miniaturized multisensory chip was developed for continuous monitoring of yeast fermentation. A dip-coated PU membrane significantly extended the linear range of the on-chip glucose sensor, tested in YPD medium.

The chip also includes pH, temperature, and conductivity sensors.



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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

A sensitive nanobiosensor designed to investigate potential DNA damage caused by Favipiravir, a drug widely used in the treatment of COVID-19

Abstract body:

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a virus that caused the pandemic, which started in China and spread all over the world in 2019. Favipiravir (FAV) is one of the antiviral drugs that has been used for Sars-CoV-2 viruses during the COVID-19 pandemic [1][2]. In this study, the electrochemical DNA-based biosensor [3] was designed for the determination of both tablet and standard form of FAV and DNA interaction by utilizing bare and multi-walled carbon nanotube (MWCNT) contained pencil graphite electrode (PGE) for the first time. In this scope, some parameters such as concentration, interaction time, nanometarials and scan rate were investigated by using differential pulse voltammetry (DPV) and cyclic voltammetry (CV) methods. The surface characterization was ensured by scanning electron microscopy (SEM) and CV. As a result, it was observed that FAV interacts with DNA and causes a significant decrease in the guanine oxidation signal and obtained enhanced detection limit with nanometarial- coated PGE compared to a non-coated one. The developed MWCNT-contained nanobiosensor can analyze DNA-Favipiravir interaction and the limit of detection (LOD) was calculated as 0.66 µg/mL with a linear range from 150 to 500 µg/mL. In addition, rapid analysis was performed due to the short determination time (approximately 32 min). Considering this information, issues such as Favipiravir's comprehensive effect on DNA and whether DNA damage caused by the DNA-Favipiravir interaction is permanent will become clearer over the years, and future studies may help identify potential new treatment indications.

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Kapetanović V. An overview of the optical and electrochemical methods for detection of DNA - drug interactions. Acta Chim Slov. 2014;61(3):555-73. PMID: 25286211.

Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Advanced Functionalization Strategies of Graphene Transistor Arrays for Sensitive Neurotransmitter Detection

Abstract body:

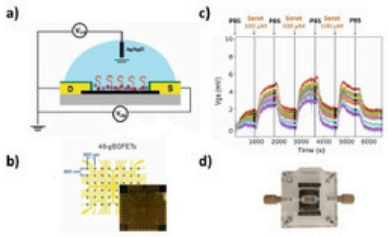
Graphene solution-gated field-effect transistors (gSGFETs) offer great promise for biochemical sensing due to their high sensitivity, label-free operation, and compatibility with miniaturized, multiplexed formats. These characteristics make them suitable for real-time monitoring [1] and point-of-care (PoC) diagnostics [2]. A critical aspect for their implementation is the development of robust and reproducible biofunctionalization strategies [3], since surface modification directly affects the device's electronic behavior. Functionalization approaches must preserve graphene's crystalline integrity while enabling selective analyte recognition to advance their use in biosensing platforms.

In this work, we have investigated pyrene-derivative linkers, particularly pyrene-maleimide (PMAL), to immobilize serotonin-specific conformational aptamers [4], enhancing detection capabilities compared to conventional approaches. [5], [6] PMAL allowed efficient aptamer immobilization without damaging the graphene lattice, as confirmed by Raman spectroscopy. High density 48 gSGFETs arrays for high-throughput measurements were employed in a custom flow cell system for serotonin detection. Real-time monitoring of aptamer conformational changes upon target recognition was achieved, employing a custom electronic system to multiple data acquisition simoultaneously, potentially increasing assay robustness and reproducibility in complex biosensing conditions.

This study demonstrates a reliable platform for reversible and real-time detection of serotonin detection, offering a promising versatile technology for future neurotransmitters monitoring in the brain and in PoC diagnostics.

Figure 1. a) Schematic of a graphene solution gated field effect transistor (gSGFET) and b) Typical I-V transfer curves change before and after functionalization b) Schematic of the layout of a chip with 48-gSGFET

array and the optical microscope image of the fabricated chip c) Detection of serotonin, combining cycles of serotonin at 100 µM and PBS 10 mM. Each line represents the response of one transistor from the array. d) Fluidic cell.



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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Advancing Biosensing with Graphene Derivatives as Efficient Signal Transducers

Abstract body:

Graphene derivatives have emerged as an interesting class of materials for constructing electrochemical biosensors, owing to their electrical conductivity, large surface area, and namely tunable surface chemistry. Among them, materials derived from fluorographene (FG) represent a particularly promising direction due to their unique capability for covalent modification under mild, controllable conditions. FG chemistry enables the synthesis of single- and double-sided functionalized graphene sheets with precisely controlled surface moieties and functionalization levels, thereby facilitating robust integration with biorecognition elements [1,2]. These functional groups ensure stable and specific covalent immobilization of biomolecules, overcoming limitations of noncovalent approaches and enabling the development of biosensors with enhanced selectivity and long-term performance [3,4].

Recent progress in fabrication methods, particularly inkjet printing, has opened new possibilities for scalable and cost-effective production of graphene-based electrodes. FG-derived graphene flakes exhibit properties ideally suited for inkjet printing, including optimized flake size, stability, dispersibility, and ink rheology. Fully inkjet-printed electrodes based on FG inks demonstrate excellent electrochemical performance, retaining the sensitivity and reproducibility required for biosensing applications [5,6]. These platforms are highly adaptable and compatible with a wide variety of analytes, paving the way for advanced biosensors in diagnostics, environmental monitoring, and industrial sensing [7].

This contribution highlights the integration of FG-derived graphene materials with inkjet printing technology as a synergistic approach for the development of efficient and sustainable signal transducers [8]. The presented results underscore the potential of graphene derivatives to serve as cornerstone materials in the next generation of high-performance electrochemical biosensors. Emerging trends and key challenges in

biosensor fabrication, such as multiplexing capabilities, scalability, and device portability, will also be addressed.

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Topics

Electrochemical transducers

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ORAL COMMUNICATION

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Abstract Title:

Applications of electrochemical biosensors containing gold or carbon nanomaterials for the determination of aptamer or DNA-based biomolecular interactions

Abstract body:

Nanomaterials, which are frequently used in the world of biosensors, still maintain their popularity in designs, allowing for sensitive analyses and the development of miniaturized devices. Global biosensor reports published in recent years also include new systems based on nanomaterials, and it is anticipated that in the near future, wearable devices containing these materials will be used more frequently in many areas such as medicine, pharmacy, agriculture, food, environment, etc. Carbon or metal-containing materials are particularly preferred by researchers in electrochemical biosensor designs due to their advantages such as good conductivity, increased surface area, and low cost.

Here, we mentioned some current biosensors/diagnostic kits used for the analysis of aptamer or DNA-based biomolecular interactions containing gold or carbon nanomaterials, which we developed to improve the detection performance of electrochemical biosensors.

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Topics

Electrochemical transducers

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Artificial intelligence-assisted electrochemical detection of bacteria

Abstract body:

The rapid detection of bacteria remains a significant challenge in clinical contexts, with consequences for both patients and the medical system. Electrochemical analysis can be adapted for the detection of microorganisms, either for the whole cell identification, or for measuring redox active molecules, such as virulence factors (specific bacterial metabolites). While the electrochemical sensors deliver fast results, the matrix effect in real samples and the overlaps of the electrochemical signals are still of major concern and cannot be overcome in the absence of biorecognition elements and samples pretreatment protocols. Combining the advantages of electrochemical techniques and the potential of siderophores as markers for infections, portable sensors can be developed for the rapid and point-of-care diagnostic 1. AI involvement in healthcare applications has the advantage of assessing trends and patterns that are difficult to be achieved due to the large amount of available experimental and clinical data 2. Starting from classification and prediction tasks, it can provide more information than electrochemical experimental data can achieve, increasing the analytical performance and minimising the interference rate and matrix effect 3. Hence, an AI-assisted electrochemical sensor that employs machine learning algorithms to classify the target signal and overcome the interferences from real samples with complex biological matrices 4. The electrochemical behaviour of three bacterial markers for *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Escherichia coli* was analyzed in human serum to estimate the impact of any potential interference, whether from the environment or between components. By integrating ML algorithms with electrochemical fast detection, this system proposes a high-throughput and cost-effective solution for the sensitive detection of three different pathogen bacteria with promising results on real clinical samples.

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N, Verma P, Verma S. Advancements in AI based healthcare techniques with FOCUS ON diagnostic techniques. Comput Biol Med. 2024;179:108917. doi:10.1016/J.COMPBIOMED.2024.108917 3. Cető X, Truta FM, Dragan AM, et al. Towards the development of a portable device based on modified-voltammetric sensors for the detection of illicit drugs and seized samples. Talanta. 2025;282:127055. doi:10.1016/J.TALANTA.2024.127055 4. Cernat A, Groza A, Tertis M, Feier B, Hosu-Stancioiu O, Cristea C. Where artificial intelligence stands in the development of electrochemical sensors for healthcare applications-A review. TrAC Trends in Analytical Chemistry. 2024;181:117999. doi:10.1016/J.TRAC.2024.117999

Topics

Electrochemical transducers

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POSTER

5th European Biosensor Symposium

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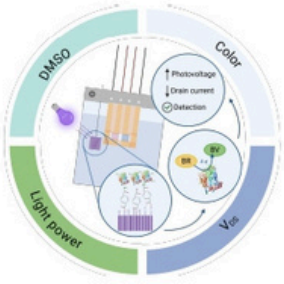
Abstract Title:

Bringing light to key parameters for better bilirubin biosensing with Organic Photoelectrochemical Transistors

Abstract body:



Organic photoelectrochemical transistors (OPECTs) offer promising amplified electrochemical detection for biosensing applications with high sensitivity, achieving LOD at the femtomolar range, while operating at low voltages (< 1 V) in aqueous electrolytes. By employing titanium dioxide nanotubes (TNTs) as a photosensitive gate, we control the OPECT with UV-light instead of voltage, reducing the requirement for power sources. However, as a new developing technology, the field lacks standardization and important parameters are often overlooked in literature. Herein, we investigate how light power, drain voltage (VDS), use of DMSO, and the color of the analyte affect detection accuracy. We evaluate these parameters with enzymatic detection of bilirubin as proof-of-concept. Highly sensitive detection of free bilirubin is of special importance in neonates, since hyperbilirubinemia can cause neurotoxic effects. The gate is biofunctionalized with bilirubin oxidase, where the electrons generated by the oxidation of bilirubin enhance the photogenerated electron transfer at the gate, dedoping the PEDOT:PSS channel, and causing a decrease in current corresponding to detection. Although immobilization of the bioreceptor is proved, high light power irradiated in the functionalized gate can damage the interface, reducing accuracy in detection. The degradation of DMSO, a solvent commonly used to solubilize free bilirubin in buffer conditions, under UV-light irradiation can lead to a false-positive response.

Moreover, when using light-controlled devices, the color of the analyte and possible interferents can lead to a decrease in light-excitation of the gate due to absorbance, also causing false-positive response. Finally, while most OPECT-based biosensors in the literature operate at VDS 0.1 V, we demonstrate that the use of negative VDS can achieve a higher signal amplification. By highlighting these features to be assessed during the development of OPECT-based biosensors, we aim to improve detection accuracy and increase reproducibility in the field to stimulate wider adoption of the technology.

Abstract References

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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Catheter-Based Impedimetric Biosensor for Histamine Monitoring in IBS Diagnosis

Abstract body:

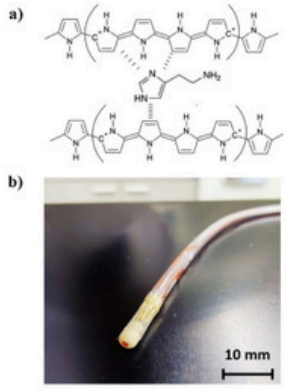
The irritable bowel syndrome (IBS) affects millions worldwide, yet diagnosis remains challenging due to the lack of reliable molecular markers. This study aims to detect histamine concentrations directly in the duodenum using a catheter-based, minimally invasive biosensor. Building on recent work, we apply molecularly imprinted polymers (MIPs) coated on gold electrodes for selective histamine detection via impedance spectroscopy in complex biological fluids. IBS is characterized by gut–brain axis dysfunction, immune activation, and altered mucosal responses. We propose this sensor platform as a step toward real-time, site-specific diagnostics for IBS.

A flexible catheter sensor was constructed by soldering 500 µm gold wires to insulated copper wires, which were twisted together for stability. Three pairs of electrodes were integrated into the catheter, with each pair functionalized with MIP and NIP. The wires were enclosed in medical-grade silicone tubing, terminated with a rounded PEEK tip for safe duodenal insertion, and included a mesh filter to prevent blockage during fluid aspiration.Electropolymerization of pyrrole monomers with histamine as the template created the MIP layers, while NIPs were prepared under identical conditions without the template. Impedance spectroscopy was performed at 37 °C in PBS to evaluate sensor performance.

A custom glass vessel setup was designed to test the catheter sensor under physiologically relevant conditions. Impedance measurements confirmed histamine sensitivity with clear MIP/NIP signal differentiation after optimizing electro-polymerization parameters. Adjusting chrono-amperometry cycles and monomer concentrations improved reproducibility, sensitivity, and polymer stability on the electrode surface.

The catheter-based biosensor demonstrated sensitive detection of histamine with an LOD of 142 pM, highlighting its potential for minimally invasive IBS diagnostics. Future work will focus on testing in Fasted State Simulated Intestinal Fluid (FaSSIF) to better mimic in vivo conditions and advance toward clinical

validation.



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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Characterization of extended-gate field-effect transistors with atomic-layer deposited high-k HfO2 as pH-sensitive material

Abstract body:

Introduction

Due to small size, fast response time, possibility of real-time and multiplexed measurements, and compatibility with advanced complementary metal oxide semiconductor (CMOS) technology, unbreakable pH sensors based on ion-sensitive field-effect transistors (ISFETs) and extended-gate FETs (EGFETs) are widely used for pH measurement in many fields, including medical diagnostics, biotechnology, food and drug industry [1,2]. Selecting an appropriate pH-sensing gate material compatible with CMOS technology is crucial for achieving highly sensitive and stable pH sensors. Among numerous proposed high-*k* oxides, hafnium oxide (HfO2) is considered as one of the best pH-sensitive materials for CMOS ISFETs and EGFETs [3].

In this work, HfO2 EGFETs were systematically characterized in terms of pH sensitivity, linear pH range, long-term stability (or drift), hysteresis, cross-sensitivity to interfering sodium ions (Na+) and impact of illumination, which determine the main analytical characteristics of pH sensors.

Results and Discussion

EGFET chips characterized in this work were developed by Texas Instruments. Each chip contains three HfO2-gate EGFETs with adjustable floating-node charge, enabling individual calibration of the EGFETs. A 25 nm thin pH-sensitive HfO2 layer was prepared by means of atomic layer deposition (ALD) method, which is compatible with commercial CMOS technology. The cross-sensitivity of ALD-HfO2 EGFETs toward interfering sodium (Na+) ions was studied using the fixed interference method (FIM) recommended by IUPAC [4]. By FIM, the EGFET signal is measured in solutions of constant activity of the interfering ion (i.e., Na+ ions) and varying activity of the primary ion (here, H+ ions).

The ALD-HfO2-gate EGFETs possess a high pH sensitivity close to the Nernstian limit, low long-term drift, small hysteresis, and negligible cross-sensitivity to Na+ ions. Impact of illumination on the EGFET signal was

moderate. Details of experiments and obtained results will be presented at the conference.

Acknowledgements

The authors would like to thank P. Bühlmann for valuable discussion.

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Topics

03 Electrochemical transducers -

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Abstract Title:

Characterization of functionalized ISFETs with automated measurement platform

Abstract body:

Background

We were studying the pH sensitivity and immobilization characteristics of Ta_2O_5-gated ISFETs (ion-sensitive field effect transistors) on which a discontinuous gold layer was sputtered. The gold should provide binding sites for thiolated receptors (aptamers or antibodies) to functional-ize them as biosensor. A discontinuous gold layer was chosen a) to prevent short-circuiting of multiple ISFETs on a single chip and b) to retain pH sensitivity of the underlying Ta_2O_5 surface as best as possible, allowing to perform sandwich-type H^+-ion sensitive ELISAs (enzyme-linked immunosorbent assays). pH characterization of the ISFETs was carried out in a self-developed, automated measurement platform (see Fig. 1).

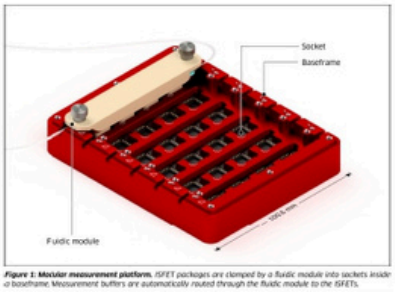

Figure 1: Modular measurement platform. *ISFET packages are clamped by a fluidic module into sockets inside a baseframe. Measurement buffers are automatically routed through the fluidic module to the ISFETs.*

Materials & Methods

A 3 nm gold layer was sputtered on ISFET packages (3 ISFETs per package) from Texas Instru-ments with a Leica EM ACE600. Gold-sputtered and blank control packages were character-ized in Merck Titrisol buffers at pH 5 to 9. The complete measurement was automated using a script to control buffer exchange via a selection valve.

Results

In first pH characterization, a sensitivity of 54.45 ± 0.28 mV/pH (mean ± standard deviation, n = 3) was determined for the gold-sputtered ISFETs, which was somewhat smaller as for the blank controls (57.01 ± 0.01 mV/pH). The pH characterization was followed by a 20 h conditioning in pH 7, during which the gold-sputtered ISFETs drifted by an average rate of 620 ± 74 µV/h, while the controls remained virtually stable with 74 ± 4 µV/h. In a subsequent second pH characteri-zation, the difference in sensitivity between the gold-sputtered ISFETs and controls was dis-tinctly reduced with 57.84 ± 0.07 mV/pH and 57.01 ± 0.06 mV/pH, respectively.

Conclusions

After conditioning, the gold-sputtered ISFETs achieved the same pH sensitivity as the blank ones. Currently, experiments with aptamers are performed on the gold-sputtered ISFETs which will be presented at the conference.

Abstract References

Topics

Electrochemical transducers

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Combining xanthine dehydrogenase (XDH) with electrochemical and photoelectrochemical systems

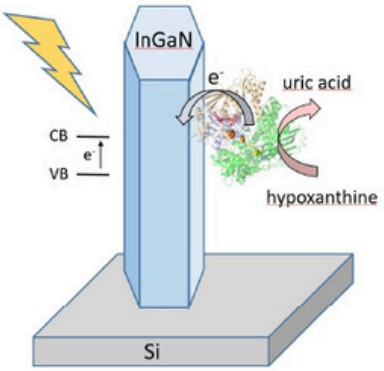
Abstract body:

Hypoxanthine – a degradation product of ATP breakdown - serves as biomarker for ischemia, inflammation, and the spoilage of meat and fish. A reliable detection is thus, of great interest in clinical diagnostics and food quality monitoring. Electrochemical biosensors offer promising platforms due to their sensitivity, selectivity, and potential for miniaturization. Biosensors employing xanthine dehydrogenase (XDH) enable the specific detection of hypoxanthine. However, efficiency of electron transfer between the enzyme and the electrode remains a major challenge, especially for mediator-free or light-driven signal transduction.

Here we combined XDH with electrodes by means of a redox polymer. It can be shown that an Os-based polymer can serve as artificial interaction partner and as immobilisation matrix of the enzyme. However, it was found that the ratio of enzyme to polymer strongly influences the catalytic current when the system is fixed on a gold electrode. Another factor is the pH of the solution, which is not only originated by the enzyme activity but also the polymer-protein interaction. This mediator-based approach of enzyme-electrode communication has then been applied within an amperometric scheme to detect the substrate: hypoxanthine. Sensitivity can be provided in the range 50-3000µM.

Photoelectrochemical systems can provide additional advantages due to the changed energetic situation of the charge carriers upon illumination and the possibility of spatially resolved read-out when a defined sensor area is illuminated. Significant progress has been achieved in this field[1]. We focused on InGaN nanowires because of well-defined preparation protocols allowing a fine tuning of properties and pronounced photocurrent generation. It is found that the enzyme can be adsorbed onto this nanostructured surface. Furthermore, arguments have been collected for a direct electron exchange between enzyme and InGaN

nanowire electrodes upon illumination. Consequently, a hypoxanthine dependent photocurrent has been found which can serve as basis for a photoelectrochemical sensing system.



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Topics

03 Electrochemical transducers -

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Compact and highly sensitive potentiometric biosensors using a solid-state, vertically stacked electrochemical cell

Abstract body:

The characterization of the open circuit potential response of a recently designed solid-state vertically stacked electrochemical cell is presented [1]. First, studies are focused on the evaluation of the response to hydrogen peroxide. Then, the application of these results to build enzymatic biosensors is demonstrated. Due to the kinetic nature of the processes involved in the signal generation, it is shown that the response of this cell combines features of both potentiometric and current-based techniques. A linear relationship with the potential is observed at low concentrations of peroxide. At higher concentrations, the potential scales logarithmically with the concentration of peroxide in a non-Nernstian way. Unlike conventional potentiometric systems, it is shown that the electrode area has a strong influence on sensitivity and linear ranges. This provides ways to tune analytical performance to suit applications. Furthermore, due to the low impedance of this new cell, very low background noise levels are observed, allowing the integration with low-power electronic components to achieve significant enhancements of the signal. As a result, very simple electronic components can be used to read the signal. Limits of detection for the determination of peroxide in the order of 10 nM can be easily achieved, with linear ranges that can reach up to 10 mM. These features are demonstrated in the determination of glucose levels in artificial serum and sweat. This compact paper-based device opens new avenues for the development of robust and simple wearable and disposable biosensors for the point of need.

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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Development of 3D-Printed Aptasensor for Clinical Applications

Abstract body:

Early diagnosis of diseases is vital as it helps open many avenues for successful treatment. In this respect, the detection of disease biomarkers is of great importance in terms of medical research, clinical diagnosis and biomedical applications. For example, rapid detection of cancer-specific protein biomarkers in blood and serum samples significantly improves early diagnosis of cancers and monitoring of subsequent therapeutic treatments [1,2]. Vascular Endothelial Growth Factor (VEGF) is an important regulator of angiogenesis and is also a protein biomarker that plays an important role in tumor growth and metastasis [3]. Various methods have been proposed for the quantitative determination of VEGF. Unlike quantitative analyses, biosensor technology attracts great interest due to its advantages of high sensitivity, simple use and low cost [4]. Aptamers can be selected in vitro for any target, from small molecules to large proteins and even cells, due to their high specificity and affinity resulting from their ability to fold when bound to their target molecules. Thus, various aptamer-based biosensors can be produced [5].

In this study, a label-free electrochemical aptasensor for the diagnosis of VEGF biomarker was developed. Disposable CB/PLA electrodes produced with 3D printing technology were used for the sensor surface. VEGF aptamer sequence was immobilized on the sensor surfaces. Aptamer and target molecule interaction was analyzed by Electrochemical Impedance Spectroscopy (EIS) technique. The aptasensor was optimized for higher specifity and sensitivity.

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Topics

Electrochemical transducers

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Abstract Title:

Electrochemical monitoring of glucose and acetaminophen using sol-gel carbon-based materials as electrocatalysts

Abstract body:

Real-time monitoring of analytes represents one of the major challenges in the biomedical field, as it is essential to replace traditional analytical methods with simple and less expensive alternatives that still provide adequate performance. In this context, electrochemical sensors seem to be an interesting solution, even though they still require a great deal of development in terms of electrode material. Hence, this work focuses on the synthesis of carbon-based materials as electrocatalysts for the detection of clinically relevant analytes such as glucose and acetaminophen. The synthesis of the carbon-based materials was carried out using the sol-gel methodology assisted by microwave heating, which allows for the rapid and simple production with custom-designed properties. These sol-gel materials exhibited high porosity and electrical conductivity, properties that are commonly opposite, as well as a large surface area. Electrochemical studies were carried out using cyclic and differential pulse voltammetry for glucose, and square wave voltammetry and chronoamperometry for acetaminophen. The results reveal that the modification of bare electrodes with sol-gel carbon-based materials enhances the electrocatalytic behavior of the sensors. In the case of glucose detection, higher sensitivity was obtained compared to other less porous and electrically conductive carbon materials. Furthermore, regarding acetaminophen oxidation, the detection performance was improved in terms of sensitivity and limits of detection and quantification, also exhibiting excellent selectivity against common interferents for this analyte, even tested on real samples. These results highlight the great versatility of this type of material, enabling an improved electrochemical detection performance and also demonstrating its promising potential in this field of research.

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Topics

03 Electrochemical transducers -

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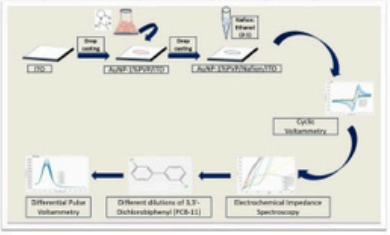
Abstract Title:

Electrochemical sensing of 3,3'-Dichlorobiphenyl using green-synthesized gold nanoparticles and Polyvinylpyrrolidone composite

Abstract body:

3,3'-Dichlorobiphenyl (PCB-11) is a persistent environmental pollutant with detrimental health impacts, requiring sensitive detection techniques. Its detection in water is of increasing environmental concern due to its classification as a non-legacy PCB associated with modern pigment manufacturing. Unlike legacy PCBs, PCB-11 continues to enter aquatic ecosystems through industrial discharge, despite global bans on PCB production. Its chemical stability and lipophilic nature contribute to environmental persistence and bioaccumulation in aquatic organisms, potentially impacting food webs and human health. The presence of PCB-11 in surface and wastewater samples underscores the limitations of conventional monitoring programs and calls for developing sensitive, targeted analytical methods to detect and quantify emerging contaminants in complex environmental matrices. This study reports the first-ever electrochemical detection of PCB-11 using a green-synthesized gold nanoparticle (AuNP) and polyvinyl pyrrolidone (PVP) composite. AuNPs were synthesized using guava leaf extract as a reducing agent using a sustainable approach, resulting in uniformly sized nanoparticles with enhanced antibacterial and electrochemical properties. The fabricated AuNP-PVP composite, deposited on an indium tin oxide (ITO) electrode, exhibited superior electrochemical activity and sensitivity, attributed to its high surface area and conductivity. Characterization via UV, XRD, FTIR, and TEM confirmed the structural integrity and nanoscale dimensions of the AuNPs. Differential pulse voltammetry (DPV) enabled the detection of PCB-11 with a limit of detection (LOD) of 0.4844 ng/L within a linear detection range of 0.625–80 ng/L. The sensor demonstrated exceptional selectivity against common interferents, ensuring reliable performance in complex environmental samples. The developed sensor offers simplicity,

high sensitivity, and eco-compatibility, marking significant progress in green analytical chemistry and environmental monitoring.



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Topics

Electrochemical transducers

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Fragment Imprinting using Epitopes and Recombinant Tags for Protein-MIPs

Abstract body:

Molecularly imprinted polymers (MIPs) are synthetic recognition materials designed to mimic the binding capabilities of natural antibodies. Among various imprinting approaches, fragment imprinting has gained attention for addressing challenges in imprinting large biomolecules such as proteins—namely, structural instability, denaturation, and difficulties in complete template removal. Instead of using the entire protein, this strategy employs a short, accessible peptide fragment (epitope) representing a characteristic region, recombinant tag, or chemical label.

In this study, two fragment-imprinted MIP-based sensors were developed: one targeting the Strep-Tag II peptide and the other for the recognition of cytochrome c using microperoxidase-11 (MP-11) as a model epitope. MP-11 retains its heme group and exhibits peroxidase-like activity, making it a suitable surrogate.

In the first system, either the cysteine-extended Strep-Tag II was chemisorbed onto a gold electrode before electropolymerization of scopoletin (hierarchical MIP), or a mixture of Strep-Tag II and scopoletin was electropolymerized (mixture MIP). Electrochemical measurements and surface-enhanced infrared absorption spectroscopy confirmed imprinting and selective rebinding. Mutation studies revealed the importance of terminal tryptophan and glutamate residues.

The hierarchical MIP displayed high affinity toward both the Strep-Tag peptide (K_D = 3.05 nM) and Strep-tagged proteins such as membrane-bound hydrogenase (K_D = 33.08 nM). Lower sensitivity of mixture-MIPs is reflected by a 20-fold higher K_D.

The second strategy employed MP-11 to compare conventional mixture-based imprinting and hierarchical imprinting using self-assembled monolayers (SAMs). Hierarchical MIPs exhibited slightly superior performance with lower LOD (5.1 nM) and higher affinity (K_D = 0.56 µM) than mixture-based MIPs.

This study demonstrates the applicability of epitope-imprinted MIPs for the selective and reproducible recognition of peptide-tagged or epitope-based biomolecules. Due to their chemical stability and design flexibility, these synthetic receptors may serve as practical alternatives to conventional bioaffinity reagents in analytical, diagnostic, and biotechnological contexts.

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Topics

Electrochemical transducers

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ORAL COMMUNICATION

5th European Biosensor Symposium

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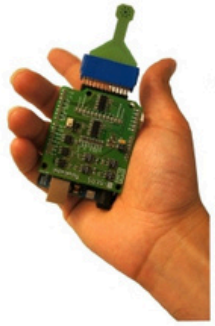
Abstract Title:

From Lab to Open Hardware: A Polyaniline-Based Biosensor for Carbapenemase-Producing Bacteria

Abstract body:



Conductive polymer-based biosensors, particularly those using solid-state transducers, hold great promise for low-cost, rapid diagnostics. Yet, their full potential remains underexploited due to limited understanding of polymer behavior in real biosensing conditions. We address this challenge with the development of an open-source, Arduino-based electrochemical platform using polyaniline (PANI) as the core sensing element.

This fully programmable shield enables real-time monitoring of redox reactions with a simplified, multiplexed potentiostat. We apply this system to detect *carbapenemase-producing Enterobacteriaceae* (CPE)—a major threat in antimicrobial resistance. By exploiting polyaniline's pH-sensitive impedance characteristics, we built a calibration-free redox titration assay capable of sensing imipenem hydrolysis, a hallmark of carbapenemase activity.

Using tailored voltage excitation and exponential decay modeling, we extracted impedance signatures correlating with enzymatic activity. The resulting BYG (Bogaerts,Yunus, Glupczynski) test demonstrated high diagnostic accuracy: 95% sensitivity and 100% specificity across 67 clinical isolates representing various β-lactam resistance mechanisms.

Designed as an Arduino UNO-compatible shield, the platform is compact, low-cost, and fully open-source—facilitating rapid prototyping, collaborative development, and educational use. The biosensor has been validated in multiple clinical microbiology labs, confirming its reliability and potential for decentralized diagnostics.

Our approach bridges cutting-edge electrochemical detection with accessible hardware design, aiming to democratize biosensor development in both research and global health contexts.

Abstract References

Sensors and Actuators 2016, B 156, page 35 to 42 ; Journal Of Clinical Biology 2016, 54 (2), page 340 to 358 ; Journal Of Clinical Biology 2017, 55 (2), page 510 to 518 ;

Topics

Electrochemical transducers

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Abstract Title:

From Lignin to Sensors: Apocynin as a Novel Functional Monomer for Electrochemical Glucose Detection

Abstract body:

Molecularly imprinted polymers (MIPs) are synthetic receptors that selectively bind target analytes, offering a robust, cost-effective alternative to biological counterparts. Apocynin (4-hydroxy-3-methoxyacetophenone), a lignin-derived monomer (Stefanska and Pawliczak, 2008; Alunga et al., 2015), was investigated for the first time, to the best of our knowledge, as a green electroactive monomer for the electrosynthesis of glucose-specific MIPs (eMIPs). Molecular docking simulations confirmed favorable interactions with glucose, particularly involving the phenolic and methoxy moieties. Its electroactivity and ability of electropolymerization were first investigated at a glassy carbon electrode (GCE) in a three-electrode setup using both cyclic voltammetry (CV) and chronoamperometry (CA). Buffers tested included acetate (pH 4.8), phosphate (pH 6.5), NaOH (pH 11.6), and 0.1 M KCl, with the latter yielding the most stable and reproducible films. Ratio of apocynin:glucose of 1:1, 18:1 and 10:1 were tested. Finally, CA at +0.90 V for 60 s with an optimized apocynin:glucose ratio of 10:1 were employed for eMIP preparation and further tests. After template removal by washing the imprinted polymer (eMIP) in KCl until signal stabilization, films were incubated with 0.5 mM glucose and rebinding was monitored at 1, 3, and 8 minutes. Rebinding efficiency of glucose was evaluated by using an indircect approach via CV using ascorbic acid as a redox probe; a significant current decrease after 8 minutes confirmed successful template recognition. Selectivity was verified against 0.5 mM fructose and lactose, resulting in negligible cross-reactivity. Sensor applicability was also demonstrated in beverage samples, confirming functionality in complex matrices. These results highlight apocynin's value as a

sustainable, water-soluble monomer for developing enzyme-free and selective sensors

Acknowledgments: This work was supported by the PhD scholarship program funded by the Italian National Recovery and Resilience Plan (NRRP).

Abstract References

Alunga, K.R., Ye, Y.-Y., Li, S.-R., Wang, D., Liu, Y.-Q., 2015. Catalytic oxidation of lignin–acetoderivatives: a potential new recovery route for value-added aromatic aldehydes from acetoderivatives. Catal Sci Technol 5, 3746–3753. https://doi.org/10.1039/C5CY00419E Stefanska, J., Pawliczak, R., 2008. Apocynin: Molecular Aptitudes. Mediators Inflamm 2008. https://doi.org/10.1155/2008/106507

Topics

Electrochemical transducers

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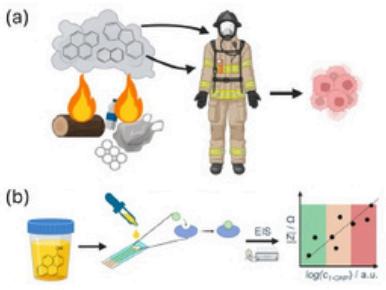
Abstract Title:

From Smoke to Signal: Impedimetric Detection of Urinary Hydroxypyrene Using MIPs to Assess PAH Exposure of Firefighters

Abstract body:

Introduction:
Combustion of organic matter leads to the formation of polycyclic aromatic hydrocarbons (PAHs), a class of pollutants linked to increased cancer risk upon exposure [1], as is illustrated in Fig. 1(a). In the human body, PAHs are metabolized to compounds such as hydroxypyrene, which serves as a widely recognized biomarker for PAH exposure, and can be detected in urine [1]. However, current detection methods for hydroxypyrene are laboratory-based techniques, limiting their accessibility for routine or field use [2]. As illustrated in Fig. 1(b), we are developing an electrochemical sensor for hydroxypyrene that can be used without specialized training or laboratory infrastructure to enable routine testing for PAH exposure using molecularly imprinted polymers (MIPs).



Materials & Methods:
The MIPs are based on a polypyrrole-polydopamine copolymer [3]. Electropolymerization was conducted in the presence of hydroxypyrene on commercial screen-printed carbon electrodes. After analyte extraction, the

modified electrodes are employed for sensing the hydroxypyrene concentration in samples using electrochemical impedance spectroscopy.

Results:
We developed a method for successful formation of a conductive polypyrrole-polydopamine film on screen printed electrodes without oxidizing the electroactive hydroxypyrene in the process. The extraction of the imprinting analyte without damaging the polymer film is currently being optimized. First measurements testing for selectivity are promising and will be expanded once the extraction procedure is sufficiently standardized.

Conclusion:
We report on the progress in developing a molecularly imprinted polymer biosensor for detecting urinary hydroxypyrene. The sensor will enable rapid, easy and reliable assessment of PAH exposure in affected professions like firefighting, to improve public health.

Abstract References

[1] F.J. Jongeneelen. Ann. Occup. Hyg. 45(1), 2001. [2] M. Frederiksen et al. Toxicol. Lett. 390, 2024. [3] S. Kim et al. Sci Rep 6, 2016.

Topics

Electrochemical transducers

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Abstract Title:

High Throughput Measurement Platform for Continuous Electrochemical Sensors

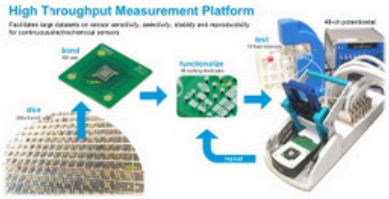
Abstract body:

By transforming from reactive to proactive care, our healthcare systems can become more effective and financially sustainable, embracing predictive, preventive, personalized and participatory ("P4") medicine [Flores 2013]. One of the pillars of this P4 framework is the availability of multi-parameter longitudinal health data for each individual. Continuous electrochemical biosensors hold promise to deliver the necessary data, being reliable and cost-effective [Campuzano 2020].However, deploying these biosensors in practice is challenging and requires overcoming many barriers [Hoekstra 2018], and a massive number of measurements to ensure sensor sensitivity, selectivity, stability, and reproducibility.

To scale up data generation for continuous electrochemical biosensors, we have developed a high-throughput measurement platform, composed of the following elements:

- **Multi-electrode chip**, realized on wafer scale using semiconductor manufacturing techniques. Each chip contains 100 individually addressable micro-electrodes, accessible by through-substrate vias. Every multi-electrode chip can accommodate up to 48 sets of electrochemical working, counter and reference electrodes. For functionalization, the working electrodes are surrounded by dry film resist microwells, facilitating the dispensing of biosensing materials.
- After dicing, bonding to an **interconnection PCB**, and functionalizing, these multi-electrode chips can be easily inserted into a high-throughput measurement setup.
- This in-house developed **high-throughput measurement setup** performs parallel electrochemical measurements (using a 48-channel potentiostat) while exposing the chips to a relevant pre-programmed set of fluidic test conditions, automatically mixed from 10 reservoirs. All measurement results are stored in a "SensorThings" database [Liang 2021] for fine-grained analysis.

We initially demonstrated our platform for oxygen sensing (by platinum electrocatalysis). Currently, we are expanding its capabilities to include sodium, potassium, and calcium sensing using ionophores, as well as glucose sensing using enzymes. We are open for collaborations on further electrochemical functionalization, aimed at achieving robust multi-parameter continuous sensing.



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Topics

Electrochemical transducers

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ORAL COMMUNICATION

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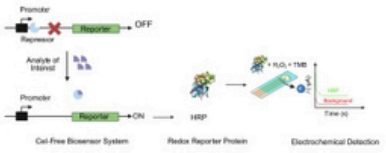
Abstract Title:

Horseradish Peroxidase As an Electrochemical Reporter Protein for Cell-Free Biosensor Systems

Abstract body:

Background

Cell-free biosensor systems provide a versatile, rapid, and cost-effective platform for detecting analytes through reporter protein expression[1]. While fluorescent proteins are commonly employed, they necessitate complex optical instrumentation and are susceptible to photobleaching and autofluorescence. To address these limitations, we evaluated horseradish peroxidase (HRP) as an alternative reporter, enabling electrochemical detection via simple hardware[3,4,5]. Electrochemical approaches offer robustness and portability, thereby enhancing biosensor applicability in point-of-need settings[2].



Materials & Methods

HRP expression was optimised in an *E. coli*-based cell-free transcription-translation system using a design of experiments approach. HRP activity was quantified amperometrically with screen-printed gold electrodes using tetramethylbenzidine as a redox mediator.

Results

HRP was successfully expressed and detected electrochemically with strong signal consistency. Amperometric measurements correlated well with spectrophotometric assays, confirming enzyme functionality. The optimised system provided an improved expression and higher signal. As a proof-of-concept, HRP expression was controlled using a tetracycline-responsive genetic circuit, demonstrating the feasibility of regulated reporter output in a cell-free format. These results indicate that HRP is a viable alternative to fluorescent reporters in cell-free biosensors.

Conclusions

Electrochemical detection of HRP expands the capabilities of cell-free biosensors, offering a simplified, robust alternative to optical methods. These findings support the use of HRP as a viable alternative to fluorescent reporters in cell-free biosensing systems. This approach enhances portability and reduces hardware complexity, paving the way for broader implementation in field-deployable diagnostic systems.

Abstract References

[1] C. E. Hodgman and M. C. Jewett, 'Cell-Free Synthetic Biology: Thinking Outside the Cell', Metab Eng, vol. 14, no. 3, p. 261, May 2012, doi: 10.1016/J.YMBEN.2011.09.002. [2] S. Bracaglia, S. Ranallo, and F. Ricci, 'Electrochemical Cell-Free Biosensors for Antibody Detection', 2022, doi: 10.1002/anie.202216512. [3] Zhu B, Mizoguchi T, Kojima T, Nakano H (2015) Ultra-High-Throughput Screening of an In Vitro-Synthesized Horseradish Peroxidase Displayed on Microbeads Using Cell Sorter. PLoS ONE 10(5): e0127479. doi:10.1371/journal.pone.0127479 [4] Park Y-J and Kim D-M (2021) Production of Recombinant Horseradish Peroxidase in an Engineered Cell-free Protein Synthesis System. Front. Bioeng. Biotechnol. 9:778496. doi: 10.3389/fbioe.2021.778496 [5] Kergaravat SV, Pividori MI, Hernandez SR. Evaluation of seven cosubstrates in the quantification of horseradish peroxidase enzyme by square wave voltammetry. Talanta. 2012 Jan 15;88:468-76. doi: 10.1016/j.talanta.2011.11.016. Epub 2011 Nov 9. PMID: 22265528.

Topics

Electrochemical transducers

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Abstract Title:

Hybrid Electrochemical Biosensors Integrating Bionanomaterials for Clinical Diagnostics

Abstract body:

Electrochemical biosensors have gained increasing prominence in clinical diagnostics due to their fast response, high sensitivity, and compatibility with miniaturized, point-of-care formats. Recent research has focused on developing hybrid biosensing platforms that combine bionanomaterials, functional nanomaterials such as gold nanoparticles, carbon nanotubes, porous/dendritic nanostructures, and graphene, with biorecognition elements including nucleic acids, enzymes, and antibodies to enhance analytical performance. The incorporation of conductive inks into electrode fabrication has enabled the realization of flexible, printable, and cost-effective biosensor architectures. These inks support the deposition of nanomaterials and facilitate efficient electron transfer across the sensing interface. In addition to enhancing electrochemical conductivity, nanomaterial-based conductive inks offer large surface areas and tunable surface functionalities, which improve the immobilization density and stability of biological recognition molecules. The resulting hybrid biosensors employed amperometric transduction to detect clinically relevant biomarkers, including proteins, antigens, and nucleic acids, in complex biological samples such as serum and plasma. These configurations demonstrated low detection limits, fast signal response, and high selectivity, even in the presence of interfering substances. Carefully optimized surface modification strategies enabled oriented and stable attachment of biomolecules, ensuring reproducibility and long-term functionality. Surface characterization techniques such as scanning electron microscopy and electrochemical analysis confirmed the successful fabrication and functionalization of the sensing interfaces.

These biosensing platforms highlight the potential of integrating nanostructured biorecognition interfaces with conductive ink-based architectures to produce sensitive, reliable, and scalable diagnostic devices. Drawing from a series of published studies, this work demonstrates the versatility and clinical relevance of hybrid electrochemical biosensors. These systems support the advancement of point-of-care diagnostics by enabling

rapid, decentralized biomarker detection and expanding access to accurate and timely testing in diverse healthcare settings.

Keywords: Electrochemical biosensors, Hybrid biosensors, Bionanomaterials, Conductive inks, Nanomaterials, Point-of-care diagnostics, Clinical biomarker detection

Abstract References

[1] Hassanpour, S. (2022). Novel electrochemical sensors for analysis of. Journal of Molecular Recognition, 35(5), e2953. [2] Hassanpour, S., et al. (2019). Nanomaterials for use in apta-assays. In Handbook of Smart Materials in Analytical Chemistry (pp. 243–271).

Topics

Electrochemical transducers

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5th European Biosensor Symposium

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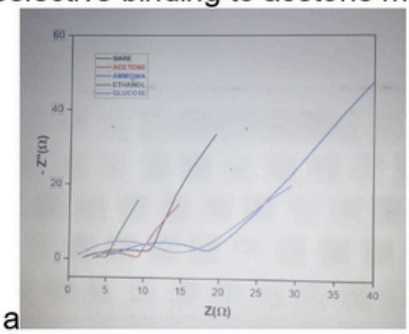
Abstract Title:

Hybrid Polymer--Metal Oxide Nanocomposite Electrode for Electrochemical Detection of Acetone as a Breath Biomarker for Early-Stage Cancer

Abstract body:

Abstract:

The detection of volatile organic compounds (VOCs) such as acetone in exhaled breath offers a promising, non-invasive route for early diagnosis of cancer, particularly lung and breast cancers.(1,2,3) Here, we report the fabrication and performance of a novel hybrid electrochemical electrode composed of polymer blends **(PANI/PCL/PVDF)** integrated with green synthesized **CuO** and **ZnO** nanoparticles using ***Centratherum punctatum.*** The synergy between conductive polymers and semiconducting metal oxides offers enhanced sensitivity, charge transfer, and selective binding to acetone molecules.The composite was blade coated onto a carbon cloth substrate to form a



Analyte	Peak potential(V)	Peak Current (micro A)	Interpretation
Bare	-	~100(baseline)	No reaction

Acetone	0.25	~510	Strong peak-good sensitivity
Ammonia	0.1-0.15	~450	Detectable response
Ethanol	O.55	~500	Moderate response
Glucose	>0.55	~400	Weak but signal is present

stable, uniform electrode surface. Structural and morphological analysis (XRD, FTIR, FESEM) confirmed the homogeneous distribution of nanostructures and polymer matrix. Electrochemical characterization using **CV, DPV and EIS** demonstrated a sensitive and stable response to acetone in the ppm to sub-ppm range, with high selectivity over common interferents such as ethanol and ammonia. The electrode exhibits rapid response-recovery time, reusability, and excellent ambient stability.This nanocomposite electrode system offers a portable, non-invasive, and cost-effective solution for early cancer screening through breath analysis. The platform may be further extended for multi-biomarker detection and integration into wearable diagnostic devices.

Keywords

Acetone detection, electrochemical electrode, nanocomposite, cancer biomarker, PANI/PCL/PVDF, CuO, ZnO, VOC sensing, breath analysis

Abstract References

References 1) Ziqi Jia, Yiwen Jiang,Tongxuan Shang,Heng Cao ,Jiayi Li ,Lin Cong , Pengming Pu ,Hengyi Xu , Yuchen Liu ,Yansong Huang , Dongxu Ma 1, Jiang Wu ,Ruijie Zhou, Xiang Wang, Chang bao Han ,Jiaqi Liu ,Advanced strategy for cancer detection based on volatile organic compounds in breath,Nanobiotechnology. 2025 Jul 1;23:468. doi: 10.1186/s12951-025-03526-4 2)V A Binson , Sania Thomas , M Subramoniam ,Non-invasive detection of early-stage lung cancer through exhaled breath volatile organic compound analysis,Med Gas Res. 2024 Dec 7;15(2):198-199. doi: 10.4103/mgr.MEDGASRES-D-24-00101 3)George B. Hanna, Piers R. Boshier, Sheraz R. Markar, Accuracy and Methodologic Challenges of Volatile Organic Compound-Based Exhaled Breath Tests for Cancer Diagnosis A Systematic Review and Meta-analysis,JAMA Oncol Published Online: August 16, 2018 2019;5;(1):e182815. doi:10.1001/jamaoncol.2018.2815

Topics

Electrochemical transducers

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Hydrogel-Gold-Nanoparticle Composites as a Potential Sensing-Transduction Element for Biomedical Sensing Platforms - Initial Investigation of Electrical Character

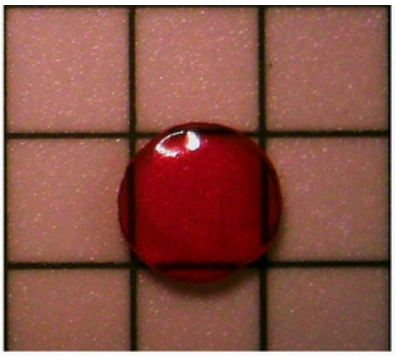
Abstract body:

Background

Smart hydrogels are 3D cross-linked polymer networks capable of responding to external stimuli via reversible volume change [1]. Owing to their biocompatibility, such materials have been the subject of recent biomedical research [2]. Certain works report on the modification of hydrogel properties by incorporation of metal nanoparticles (NPs) into the polymer matrix [3]. This is particulary relevant for the development of biomedical sensors that devise electrical detection concepts. However, in order to assess the potential of hydrogel-nanoparticle composites for utilization in electrical biomedical sensing platforms, several aspects require investigation. Those encompass the stability of the NPs over time, the impact of features such as diameter and concentration on the resultant impedimetric behavior, and the optimum frequency range for stable operation.

Methods

In this work, commerical gold nanoparticles (AuNPs) were incorporated in a polyacrylmaide (PAM) hydrogel matrix (shown below).



The resultant composites were electrically invesitgated using electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV). To systematically assess the impact of the AuNPs, diameter and concentration were varied. All samples were conditioned in phosphate buffer saline solution (PBS) between experiments.

Results

The EIS measurements conducted on the samples were used to obtain Nyquist plots providing the basis for impedance analysis. Furthermore, the maximum charge accumulated at the setup electrodes could be derived using CV. This allowed for the assessment of how the integration of AuNPs influences the migration of ions from the PBS through the sample in response to the applied electric field. It was seen that an increase in diameter as well as concentration of AuNPs led to increased difficulty of charge transport and consequently an increase in the overall impedance of the sample. This indicates that AuNPs could act as the transduction element for a hydrogel-based sensing platform that incorporates interdigitated electrodes (IDE) for an EIS-based readout.

Abstract References

[1] E. M. Ahmed, "Hydrogel: Preparation, characterization, and applications: A review," Journal of Advanced Research, pp. 105–121, 2015. [2] A. Mech-Dorosz, M. S. Khan, R. V. Mateiu, C. H´elix-Nielsen, J. Emn´eus, and A. Heiskanen, "Impedance characterization of biocompatible hydrogel suitable for biomimetic lipid membrane applications," Electrochimica Acta, 2021. [3] P. Thoniyot, M. J. Tan, A. A. Karim, D. J. Young, and X. J. Loh, "Nanoparticle–hydrogel composites: Concept, design, and applications of these promising, multi-functional materials," Advanced Science, 2015.

Topics

Electrochemical transducers

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FLASH PRESENTATION

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Abstract Title:

Hydrogel-Gold-Nanoparticle Composites as a Potential Transduction Concept for Wearable Sensing Platforms - Initial Investigation of Electrical Character

Abstract body:

Background

Smart hydrogels are 3D cross-linked polymer networks capable of responding to external stimuli via a reversible volume change [1]. Owing to their biocompatibility, such materials have been the subject of biomedical research [2]. Certain works report on the modification of hydrogel properties by incorporation of metal nanoparticles (NPs) into the polymer matrix [3]. This is particulary relevant for the development of transduction concepts relying on electrical approaches. A potential application of hydrogel-nanoparticle composites in sensing requires fundamental investigations of the nanoparticle properties (e.g., concentration, diameter) on the resulting impedimetric behavior, an optimal operating frequency range and the stability of the nanoparticle incorporation into the polymer matrix.

Methods

In this work, commerical gold nanoparticles (AuNPs) were incorporated into a polyacrylmaide (PAM) hydrogel matrix. The resultant composites (figure 1a) were electrically invesitgated using electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV).

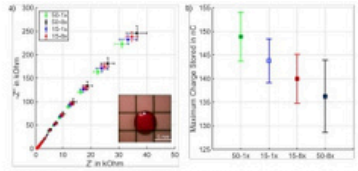

Figure 1. a) Onset: PAM-AuNP composite of 5 mm diameter and 1 mm thickness. A Nyquist plot of PAM-AuNP composites of varying diameter-concentration combinations (ø = 50 nm; 15nm and concentration = 1x; 8x) can be seen. b) Example of maximum charge accumulated at measurement electrode – calculated from CV voltage-current curves for different PAM-AuNP samples of varying diameter-concentration combinations

To systematically assess the impact of the AuNPs, diameter and concentration were varied. All samples were conditioned in phosphate buffer saline (PBS) solution between experiments.

Results

The EIS measurements conducted on the samples were used to obtain Nyquist plots (figure 1a) providing the basis for impedance analysis. Furthermore, the maximum charge accumulated at the setup electrodes was determined through CV (figure 1b). This allowed for the assessment of how the integration of AuNPs influences the migration of ions from the PBS through the sample in response to the applied electric field. It was found that an increase in diameter as well as concentration of AuNPs led to increased difficulty of charge transport and consequently an increase in the overall impedance of the sample due to the nanoparticles acting as plasmonic charge centers. This indicates that AuNPs could act as the transduction element for a hydrogel-based sensing platform that incorporates interdigitated electrodes (IDE) for an EIS based readout.

Abstract References

[1] E. M. Ahmed, "Hydrogel: Preparation, characterization, and applications: A review," Journal of Advanced Research, pp. 105–121, 2015. [2] A. Mech-Dorosz, M. S. Khan, R. V. Mateiu, C. Hélix Nielsen, J. Emnéus, and A. Heiskanen, "Impedance characterization of biocompatible hydrogel suitable for biomimetic lipid membrane applications," Electrochimica Acta, 2021. [3] P. Thoniyot, M. J. Tan, A. A. Karim, D. J. Young, and X. J. Loh, "Nanoparticle-hydrogel composites: Concept, design, and applications of these promising, multifunctional materials," Advanced Science, 2015.

Topics

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Abstract Title:

Integrating the latest generation of electrochemical and proteomic technologies for plasmatic nucleosomes analysis in colorectal cancer

Abstract body:

The detection of circulating blood nucleosomes has emerged as minimally invasive strategy in oncology than conventional diagnostic approaches for improving cancer diagnosis and prognosis. Nucleosomes can be released into the bloodstream after cell apoptosis under certain pathological conditions. They consist of double-stranded DNA fragments wrapped around histone octamers (pairs of H2A, H2B, H3 and H4 histones) with tails extending from the octamers that undergo post-translational modifications, promoting cancer progression [1]. Notably, it has been demonstrated that patients with breast, lung, prostate and colorectal cancer (CRC) show elevated circulating nucleosome levels compared to healthy controls, particularly in advanced cancer stages [2].

Leveraging the beneficial properties of cutting-edge electrochemical technologies compared to traditional techniques, such as sensitivity, rapid response, low cost, and portability, we present the first electrochemical immunoplatform for the selective isolation and quantification of circulating nucleosomes, targeting the H3.1 histone variant. The developed biotool not only allowed the simple and rapid nucleosome detection (limit of detection of 7.82 ng mL−1) but also demonstrated its potential to discriminate the metastatic potential of CRC cell lines, while assessing H3.1 nucleosome abundance levels in plasma samples of healthy individuals and advanced CRC patients with just 0.5 µg cell extracts and 1:5 diluted plasma. The synergy with proteomic profiling allowed us to confirm nucleosomes isolation as well as revealing significant differences between healthy and advanced CRC patients. Moreover, ten extracellular proteins, four of them listed in databases as prognostic factors in cancers other than CRC were identified [3], demonstrating the usefulness of nucleosome and nucleosome-associated proteins as CRC prognostic biomarkers in liquid biopsy.

These pioneering findings regarding circulating H3.1 nucleosomes and their associated proteins, combining advanced electroanalytical and proteomic technologies, open new possibilities for enhancing cancer detection by identifying and validating specific combinations of nucleosomes and nucleosome-associated proteins linked to different cancer types.

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Topics

03 Electrochemical transducers -

Gamella Carballo, Maria[1]; Tejerina-Miranda, Sandra[1]; Carral-Ibarra, Elisa[2]; Montero-Calle, Ana[2]; Pedrero, María[1]; Pingarrón, José M.[1]; Barderas, Rodrigo[3]; Campuzano, Susana[4]

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Integration of palladium--graphene nanohybrids on Si-based electrochemical sensors for food quality monitoring

Abstract body:

Background

The increasing demand for real-time, sensitive, and portable analytical platforms to monitor food quality has driven the development of advanced electrochemical sensors based on functional nanomaterials [1]. In this study, we present a miniaturized electrochemical sensor fabricated on a Si/SiO_2 substrate incorporating a nanocrystalline graphite (NCG, PECVD) working electrode, which exhibits excellent conductivity and compatibility with microfabrication technologies. To enhance its electrocatalytic performance, the electrode was functionalized with a nanocomposite consisting of graphene decorated with palladium nanoparticles (PdNPs–Gr) via a drop-casting method. Acetic acid (AcOH) is a key volatile organic acid and a recognized biomarker for food spoilage and fermentation processes.

Materials and methods

The morphology and composition of the PdNPs–Gr nanocomposite (electrochemically synthesized *in situ*) were thoroughly characterized by SEM, EDX, TEM, FTIR, XRD, and Raman spectroscopy. Electrochemical studies, including cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) were performed using a 302N AUTOLAB potentiostat from Metrohm.

All these analyses confirmed the successful decoration of graphene sheets with uniformly dispersed Pd nanoparticles, with particle sizes in the nanometric range and characteristic peaks confirming the crystalline phases of both nanomaterials.

Results

The electrochemical studies revealed significantly enhanced electron transfer kinetics at the PdNPs–Gr/NCG electrode surface, with a marked decrease in charge transfer resistance and improved peak-to-peak separation. This enhanced electrochemical behavior was leveraged for the development of an analytical method for the detection of AcOH, with an LOD of 50 µM. The PdNPs–Gr sensor demonstrated excellent sensitivity, selectivity, and repeatability in the electrochemical detection of AcOH.

Conclusions

These results underscore the potential of integrating microfabricated NCG-based sensors with functional nanomaterials such as PdNPs-Gr for the development of high-performance, on-site diagnostic tools in the field of food safety, environmental monitoring, and biomedical sensing.

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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Label-Free Electrochemical Nanobiosensor for Rapid Monitoring of MCF-7 Cancer Cell-Daunorubicin Interactions

Abstract body:

Understanding and determining the interaction mechanisms of anticancer drugs with cancer cells is crucial for cancer diagnosis, treatment, and the development of new molecules in the field. Biosensors offer a powerful alternative for studying cancer cell–drug interactions due to their ability to provide rapid, sensitive, and low-cost analysis, ease of use, and non-invasive nature.

Sensitive biosensing of MCF-7 cancer cell–Daunorubicin (DNR) interactions was performed using disposable electrochemical nanobiosensors based on ZnO-modified pencil graphite electrodes (PGEs). Interactions were analyzed via cyclic voltammetry (CV) and differential pulse voltammetry (DPV), both on the sensor surface and in solution.

The ZnO-modified nanobiosensors developed for cell–DNA interaction studies required 16 minutes of preparation, including cell immobilization, with a total analysis time of 27 minutes. Compared to existing biosensors, the proposed system enables significantly faster detection of MCF-7 cells and their interactions with daunorubicin (DNR). The limit of detection (LOD) for the cell-based nanobiosensor was approximately 14 cells/mL.

To date, no nanobiosensor or biosensor has been reported in the literature that enables the analysis of DNR drug interactions directly on cancer cells immobilized onto the electrode surface, without the use of any labeling agents, indicators, or biomarkers. This approach has been investigated for the first time in this study and is considered a potential model for future research.

The designed nanobiosensors are also considered to be model systems for the analysis of different drugs, cancer cells, and their interactions. Moreover, these sensors are believed to have the potential to be transformed into kits and to serve as a strong alternative to existing methods, as ready-to-use, disposable models for use by healthcare professionals in clinical applications.

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Topics

Electrochemical transducers

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Abstract Title:

Laser Induced Graphene based Flexible Platform for Wound Care Applications

Abstract body:

Introduction

Chronic wounds impact millions of people globally and represent a major economic challenge due to their prolonged healing times and high risk of infection. Recent years, there has been increasing interest in the development of wearable, flexible sensors for chronic wound monitoring and gain valuable insights on wound conditions. Assessing pH and uric acid value of wounds is crucial for proper diagnosis and effective management [1]. In this work, our aim is to develop flexible smart bandage incorporating a multi-sensing platform based on laser induced graphene (LIG). The sensors are fabricated using a low-cost hobbyist 450 nm laser on polyimide tape by direct laser writing technique for monitoring wound pH and uric acid level.

Results and discussion

The potentiometric pH sensor was fabricated modifying the working electrode by electro polymerization of polyaniline. This sensor showed high sensitivity close to the Nernstian response and good reproducibility with low hysteresis in the wide range of pH buffer solutions. During the long-term stability test, the sensor showed a less amount of potential drift proved the sensor is suitable for wound care application.

A non-enzymatic uric acid sensor based on the catalytic activity of LIG electrode has been developed to monitor wound uric acid. The sensor showed good response in the presence of common interfering ions like ascorbic acid and dopamine. Finally, the sensor tested in artificial wound exudate for checking its applicability on real device integration.

Conclusions

The multisensory platform shows promising performance in detecting key wound biomarkers. Next step is to integrate the sensors with electronics for further testing including patient's samples.

Acknowledgements

This research was carried out with financial support from the Science Foundation of Ireland (SFI) under the European Regional Development Fund Grant No. 13/RC/2077-P2 (CONNECT).

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Topics

Electrochemical transducers

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Abstract Title:

Laser-nanostructured film-based transducers assembled via benchtop technologies. Toward integrated paper-based third-generation biosensors

Abstract body:

The synthesis and integration of nanostructured films (nanofilms) into lab-made flexible and paper-based analytical devices still represent a critical issue. To overcome tedious, expensive, and unsustainable conventional fabrication techniques, several efforts are devoted to implementing effective and affordable technologies to produce nano-equipped devices. In this framework, benchtop-scale CO_2 laser plotter-based technologies represent a captivating opportunity.

Herein, the production of functional surfaces and nanofilms via CO_2-laser plotter and their integration within fructose dehydrogenase (FDH) based lab-made 3rd generation biosensors will be presented. Attention will be paid to nanostructured surface laser-assisted assembling, and fabrication of disposable devices using low-cost/sustainable substrates (i.e., flexible polymers, recycled paper, etc.) via affordable benchtop microfabrication technologies as stencil-printing, cutter-plotting, laser molding, thermal-lamination, etc.

In particular, (i) a strategy to stamp laser-produced Reduced Graphene Oxide (rGO) onto flexible polymers using only office-grade tools, namely, roll-to-roll thermal stamping, will be presented, proving superior electrocatalysis and D-fructose determination at nanomolar level (LOD = 0.2 µM). (ii) A fast CO_2 laser approach to activate commercial carbon Inks towards direct enzymatic bioelectrocatalysis will be proposed; the sensors were produced via a fast and scalable stencil printing approach. Laser-activated printed biosensors were successfully used for D-fructose determination in different biological fluids (Recovery 93–112%), proving the ability for in-continuous measurement (1.5h) in cerebrospinal fluid. (iii) Eventually, a paper biosensor integrating polyimide-derived Laser-Induced Graphene (LIG) for the determination of inulin will also be presented. LIG integration into office, recycled, and industrial by-product-containing papers was attempted, and the resulting bioelectrocatalytic features were investigated. LIG-biosensors assembled on bamboo fiber

'tree-free' paper proved to be more effective and, thus, were employed to detect inulin in urine (LOD = 0.3 mg L^{-1}) and serum (LOD = 1.1 mg L^{-1}) at levels of clinical interest in the framework of the glomerular filtration rate (GFR) testing.

Abstract References

Acknowledgments This research was funded by the European Union–Next Generation EU. Project Code: ECS00000041; Project CUP: C43C22000380007; Project Title: Innovation, digitalization and sustainability for the diffused economy in Central Italy-VITALITY

Topics

Electrochemical transducers

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Abstract Title:

Microfluidic magneto-assay for the electrochemical detection of extracellular vesicles from colon cancer cell lines

Abstract body:

Extracellular vesicles (EVs) are nano- to sub-micrometre membrane-bound particles secreted by cells, whose characteristics and composition mirror those of their parent cells. Found in blood, urine and other readily available biological fluids, EVs have recently gained wide interest as key mediators of intercellular communication and as carriers of precious information about tumour onset, progression, and therapeutic response. However, their inherent fragility and the absence of standardised analytical workflows make the development of robust detection schemes particularly challenging. In this work, we present an automatable magneto-assay for the electrochemical detection of EVs, integrated into a continuous-flow microfluidic platform. Superparamagnetic beads, functionalised with biorecognition elements targeting surface-embedded structures on EVs, capture the latter inside the microchannel, while an external magnetic field ensures stable localisation. The beads are exposed to a sequence of reagents and washing solutions under controlled flow conditions, optimised to minimise vesicle disruption. At the end of the procedure, the bead-EV conjugate is marked with an enzyme and directed into an electrochemical cell, where the enzymatic conversion of an appropriate substrate produces an amplified electrochemical signal registered by a built-in potentiostat. Software-controlled systems handle the whole procedure, which requires minimal human intervention. Special care was taken to adapt the workflow to the EVs' inherent fragility, including temperature control, incubation conditions, and mechanical handling. The protocol was successfully tested on EVs isolated from colon cancer cell lines.

Acknowledgements

Patrick Severin Sfragano was supported by Fondazione Umberto Veronesi.

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Topics

Electrochemical transducers

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Abstract Title:

MULTI-FIELD ELECTROCHEMICAL PLATFORM FOR MULTIPLEX DETECTION OF ANTIBIOTIC RESISTANCE GENES

Abstract body:

The rapid spread of antibiotic resistance poses a serious threat to global public health. Conventional methods used to identify pathogens' resistance to specific antibiotics are usually complex, time-consuming, and fail to provide actionable data within clinically relevant timeframes. To address this challenge modern diagnostic tools are required to quickly identify pathogens' susceptibility to antibiotics [[1]]. Advances in e.g. molecular diagnostics or microfluidics are heading toward the development of devices that enable automation and minimal user involvement. Nucleic acid amplification techniques integrated into a multiplex format and combined with a proper detection method enable rapid identification of genes associated with resistance to specific antibiotics. For this application, electrochemical techniques pose an attractive solution due to their ease of miniaturisation and low manufacturing costs [[2]].

This research focuses on the development of a multi-field electrochemical DNA biosensor, which allows for simultaneous detection of several fragments of amplified vancomycin, methicillin, and β-lactam resistance genes. The detection mechanism used is based on a conformational change of the DNA structure (hairpin structure, labelled with methylene blue). The self-manufactured, elastic, multi-field, gold, planar transducers fabricated in printed electronics technology with four working electrodes were used in this study to detect 4 different resistance genes at once and the working conditions of such devices were optimized. The real sample containing the single-stranded product was obtained by conducting an asymmetric polymerase chain reaction and the sensor's ability to detect amplified sequences with very high selectivity on a planar transducer was confirmed.

This work confirms the possibility of using the developed sensor manufactured on flexible planar transducers produced using printed electronics technology for the simultaneous detection of several resistance genes in

the unpurified PCR post-reaction mixture.

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Topics

Electrochemical transducers

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Neurodegenerative Disease Monitoring via Wearable OECTs Textile Biosensors

Abstract body:

Among central nervous system (CNS) disorders, Epilepsy, Alzheimer's, and Parkinson's diseases (APD), a progressive neurodegenerative disorder, demand improved strategies for early detection and continuous monitoring due to their complex and dynamic symptomatology. Recent advancements in wearable biosensing, particularly microfluidic-based electrochemical systems integrated with nanomaterials, offer transformative solutions for non-invasive, real-time disease tracking, showing a correlation with specific biomarkers in biological fluids [1]. Furthermore, the emerging field of organic bioelectronics, especially the integration of conducting polymers into microphysiological systems, highlights the potential of soft, mixed ionic-electronic interfaces to bridge biological and electronic systems [2]. We present the fabrication of organic electrochemical transistors (OECTs) based on functionalized organic conductive polymers for Alzheimer's and Parkinson's disease (APD) management via continuous sweat analysis. OECTs are known for their real-time signal processing and high sensitivity; they have emerged as powerful tools for early diagnosis and continuous physiological monitoring, supporting personalized therapeutic platforms [3,4]. The active channel comprises PEDOT: PSS blended with polyaniline (PANI) to enhance electrical performance and biocompatibility and has been functionalized with specific bioactive molecules. The addition of decyl benzenesulfonic acid (DBSA) improves interfacial adhesion, while polyethylene glycol (PEG) boosts ionic mobility and long-term conductivity. PEG-based surface modification also reduces biofouling and enhances sensitivity in OECTs biosensors to improve correlations with Alzheimer's and Parkinson's diseases (APD) [5]. The devices have been characterized, measuring transconductance, sensitivity, and operational stability. To determine the correlation with neurodegenerative disease, we performed tests on patients, comparing OECT biosensor sweat monitoring with physical sensors monitoring (pressure sensors and accelerometers) and diagnostic data. In such a way, we showed that sweat monitoring has been used for a non-invasive real-time correlation with neurodegenerative diseases. Overall, this work proposes a novel, flexible OECTs-based

sensor for early detection and personalized monitoring of Neurogenerative disease, advancing the frontier of decentralized, patient-centric healthcare.

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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Pathogen-on-a-Chip: Impedance-Based Detection of Biofilm Formation of Staphylococcus aureus and Staphylococcus epidermidis

Abstract body:

Bacterial biofilms are complex microbial communities that adhere to surfaces and contribute to the pathogenesis of chronic infections. Therefore, it is crucial to detect biofilm-associated infections as their treatment becomes more complicated. Herein, we describe a label-free electrochemical impedance spectroscopy (EIS) method for detecting biofilm formation by *Staphylococcus aureus* and *Staphylococcus epidermidis*. Printed circuit board-based biamperometric gold electrodes were modified with poly-L-lysine to enhance bacterial attachment to the sensor surface [1]. Formation and inhibition of formation of biofilms were evaluated based on changes in charge transfer resistance (R_{ct}). The R_{ct} value increased from ~ 30 kΩ for the control group to ~ 120 kΩ for *S. epidermidis* biofilm and ~ 90 kΩ for *S. aureus* biofilm. The antibiotic-treated samples exhibited values similar to the control. Furthermore, biofilm formation on electrodes was confirmed through optical microscopy, and atomic force microscopy (AFM) [2] was used to visualize the biofilm on the electrode surface and evaluate its roughness. The roughness parameters indicate that *S. aureus* forms a rougher biofilm than *S. epidermidis*, while *S. epidermidis* produces more compact biofilm and a higher amount of extracellular polymeric matrix, resulting in increased *R*ct values. These findings suggest that the optimized EIS-based method effectively monitors changes related to biofilms and serves as a promising tool for evaluation of new anti-biofilm agents, such as antibiotics, phages or antibodies.

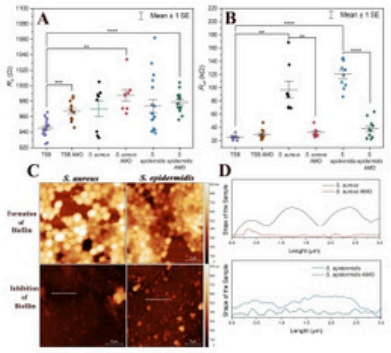

Figure 1. Comparison of biofilm formation and inhibition on gold electrodes. **(A)** R_s values and **(B)** R_{ct} values for biofilm-forming electrodes, antibiotic-treated electrodes, TSB with antibiotics (TSB AMO), and TSB (control). **(C)** AFM height sensor images of electrodes incubated with *S. epidermidis* and *S. aureus* in TSB (biofilm formation) and in TSB containing antibiotics (biofilm inhibition). **(D)** Cross-sectional height profiles (3 µm) on each electrode surface.

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Topics

Electrochemical transducers

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FLASH PRESENTATION

2025 EBS

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Abstract Title:

Quantifying Perfluorooctanoic Acid: A MIP-Based Impedimetric Sensor Approach

Abstract body:

Introduction

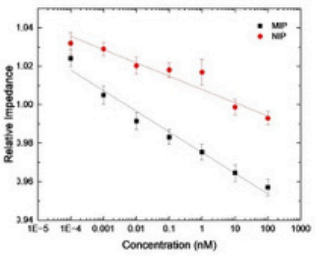
Polyfluoroalkyl substances (PFAS) have been under increased scrutiny due to their ability to bioaccumulate in animals and resistance to deterioration, so there is a need for rapid, accurate, reasonably priced PFAS detection[1]. MIP biosensors present themselves as an alternative with higher stability and robustness, with the ability to mimic the behaviour of natural biomolecules[2]. This research aims to functionalize a C-SPE with a MIP and to use Electrochemical Impedance Spectroscopy as a readout technique, since the final goal would be to create a highly selective, fully operational device.

Materials & Methods

A novel monomer was electropolymerized in the presence of PFOA via cyclic voltammetry (CV) under controlled conditions. The same procedure was done for the NIP but without the target. The removal method was also optimized so that we could remove the target (PFOA) without damaging the cavities. Finally, the analytical performance of the sensor was evaluated by using the EIS technique.

Results

After the Electropolymerization process, the performed CVs showed a clear difference in current between MIP and NIP. The removal process was also successful since the MIP presented a change in current while the NIP did not, meaning that the target (PFOA) was removed from the MIP without disturbing the cavities structure. As to the dose response, the absolute impedance decreased with the PFOA concentration, presenting a linear response between 0.1pM and 100nM while the NIP did not respond, as expected. This biosensor presents a limit of detection of 0.5pM.



Conclusion

This research presents one of the first impedimetric MIP biosensors PFOA detection. The incorporation of the novel electropolymerized monomer enables the development of a highly sensitive biosensor since it presents a clear interaction with the target. Overall, the biosensing device exhibits remarkable potential in terms of sensitivity, selectivity, and reproducibility.

Abstract References

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Topics

Electrochemical transducers

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Abstract Title:

Redox-cycling and volume confinement on gold-interdigitated microelectrodes (G-IDE) as efficient electrochemical signal amplification strategies for biological magneto-immunoassay detection

Abstract body:

Intro:

In this work, we report the system characterisation of G-IDE chronoamperometric electrochemical signal transduction, integrating two signal amplification strategies: redox cycling and volume confinement (1,2).

We aim to improve a biosensing methodology based on single-step sandwich magneto-immunoassay for detecting low-concentration analytes, using paramagnetic microparticles (MMPs) as capture surface and enzymatically labelled detection antibodies for signal transduction (3)

Definition of the system´s requirements regarding enzymatic labelling, reaction volume and prototyping material significantly impacts assay performance.
These results support a forthcoming proof-of-concept experimental setup with enhanced detection capabilities.

Material and methods:

The system comprises a 2 mm diameter G-IDE, 20 µm wide and an inter-electrode distance of 20 µm connected to a SMU source meter (Keithley 2450).

Streptavidin-conjugated horseradish peroxidase (SA-HRP) and biotinylated 10 µm polystyrene MMPs were used for signal transduction and target capture, respectively. 3,3′,5,5′-Tetramethylbenzidine (TMB) served as the redox substrate.

For initial system definition, a simplified immunoassay was employed by directly functionalizing MMPs with the redox enzyme. Single-MMP chronoamperometric assays were conducted under parametric variation involving reaction volume, different enzymatic redox labels and various materials (PMMA, SU-8 and PDMS) to investigate signal intensity dependence, S/N ratio and potential autocatalytic effects.

Figure: Details of G-IDE.

Results and discussion:

Preliminary assays revealed measurable chronoamperometric signals under varying conditions.

Parametric variations in reaction volume and enzymatic labelling showed distinct trends in signal intensity and background noise. Notably, the use of labelling enzymes with enhanced signal strength and reduced volumes increased signal-to-noise ratios. However, enhanced catalytic activity can have strong drawbacks due to the precipitation-prone characteristic of TMB. Material-dependent effects were observed, helping identify suitable inert substrates.

These findings support the relevance of system-level optimisation, validating the chosen approach and providing the foundation for the development of a robust, single-step magneto-immunoassay platform with improved sensitivity and reproducibility.

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Topics

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FLASH PRESENTATION

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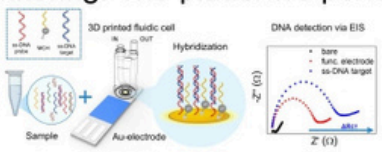
Abstract Title:

Sensitive Electrochemical Biosensor for Environmental DNA Detection

Abstract body:

Environmental DNA (eDNA) has emerged as a powerful tool for species detection and biomonitoring, offering superior sensitivity and efficiency compared to traditional survey methods.[1] Although PCR-based techniques currently dominate eDNA analysis, their inherent limitations - including high costs, operational complexity, and requirement for specialised personnel - restrict their application in real-time monitoring scenarios. Impedimetric biosensors have gained attention as a promising alternative, offering advantages in sensitivity, selectivity, and cost-effectiveness. Building upon our previous work with functionalized gold screen-printed electrodes (AuSPEs) [2], this study presents a significant advancement in eDNA detection through the development of an innovative Electrochemical Impedance Spectroscopy (EIS)-based biosensor platform. The biosensor design integrates thiolated single-stranded DNA (ssDNA) probes immobilised on Au-SPEs with a custom 3D-printed PLA fluidic cell. This configuration enables precise control over probe deposition and enhances hybridisation kinetics through optimised fluid dynamics, as confirmed by COMSOL simulations. The detection mechanism relies on monitoring changes in electrochemical impedance following target DNA hybridisation, eliminating the need for complex labelling procedures or target amplification. Performance evaluation demonstrated exceptional sensitivity with a detection limit of 0.1 pM (0.6 pg/mL) in PBS, achieved without any target amplification or sample pretreatment. Crucially, the biosensor maintained robust performance in complex biological matrices, successfully detecting target DNA in untreated *Saccharomyces cerevisiae* culture supernatants. Specificity testing revealed single-base mismatch discrimination capability and no cross-reactivity with non-target micro-organisms supernatant (*Escherichia coli* and *Candida albicans*). The integrated fluidic system enabled rapid detection (<30 minutes) and high-throughput operation, significantly outperforming conventional diffusion-limited systems.[3] This approach combines sensitivity with simplicity, making it suitable for point-of-care (POC) applications, spanning environmental surveillance, clinical

diagnostics, and industrial process monitoring. The platform's performance in untreated biological media underscores its real-world practicality. 

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[1] Thomsen, P. F.et al. A vision for global eDNA-based monitoring in a changing world. Cell 187, 4444-4448 (2024). [2] D'Aponte, T. et al. Rapid detection of Candida albicans in urine by an Electrochemical Impedance Spectroscopy (EIS)-based biosensor. Sensors and Diagnostics 2, 1597-1604 (2023). [3] D'Aponte, T. et al. Electrochemical biosensor with custom fluidics for amplification-free, low-picomolar DNA detection (submitted to Analytica Chimica Acta)

Topics

Electrochemical transducers

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Abstract Title:

Silk Fibroin as a "Green Matrix" for Enzyme Immobilization exemplified for Amperometric Glucose Sensing

Abstract body:

Background

Electrochemical biosensors can monitor key physiological parameters, however, to be implantable they require biocompatible (and ideally bioresorbable) materials. Silk-fibroin, derived from *Bombyx mori* cocoons, offers excellent mechanical properties, biocompatibility, and tunable degradation [1]. It can be fabricated as e.g., membranes, hydrogels and sponges, finding application for different sensors [1-8]. At the same time, studies showed that silk-fibroin enhances glucose oxidase (GOx) storage capability and improves its resistance to pH and temperature fluctuations [9-11]. We therefore investigated silk-fibroin as a novel immobilization matrix in amperometric glucose biosensors.

Materials & methods

GOx was immobilized on screen-printed carbon working electrodes [12,13] using comparatively a BSA/glutaraldehyde- and a silk-fibroin-based immobilization matrix (see figure 1). Different methods to form a water-insoluble silk-fibroin matrix with optimal silk-fibroin content and enzyme loading, as well as influences of pH and temperature variations were analyzed and compared.

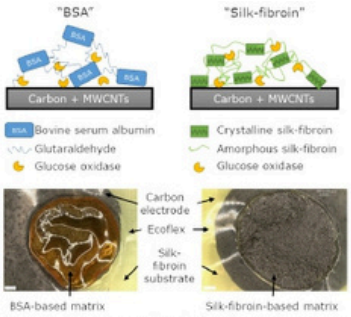

Figure 1: Schematic overview (top) and exemplary pictures (bottom) of the working electrode used in this study based on either the laboratory standard using bovine serum albumin and glutaraldehyde (left) or the novel silk-fibroin immobilization matrix (right).

Results

While all methods tested to form a water-insoluble silk-fibroin matrix were successful, a short immersion in ethanol resulted in optimized sensor characteristics: here, a GOx loading of 0.6 U in the membrane with a silk-fibroin content of 0.5 wt% was adjusted. The results also showed, as reported in literature, that the pH optimum of GOx is increased when embedded in silk-fibroin. With respect to temperature variations, a temperature optimum of the GOx embedded in the silk-fibroin matrix was found to be between 40 to 50 °C.

Conclusions

The silk-fibroin-based immobilization matrix carrying GOx led to comparable results to the BSA/glutaraldehyde-based immobilization matrix for the tested glucose biosensor, while simultaneously reducing the enzyme loading by up to 96%. The silk-fibroin matrix has the advantage of avoiding toxic components, such as glutaraldehyde, being fully biocompatible and bioresorbable.

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Topics

Electrochemical transducers

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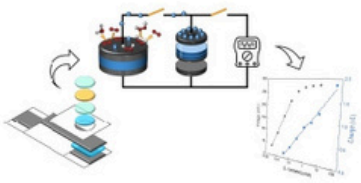
Abstract Title:

Time-Based Modulation Approach for Lactate Detection at High Concentration

Abstract body:



The diversity of biomarkers—ranging widely in type, abundance, and detectability—poses a central challenge in designing diagnostic tools suitable for varied clinical contexts.[1] High-range detection of biomarkers like lactate is vital in clinical and sports diagnostics, yet many electrochemical sensors fail to maintain linearity beyond a few millimolar and undergo saturation effects since strictly bound to the nature and kinetics of the governing reaction. The clinical concentration of L-lactate in physiological fluids like blood and sweat goes from 0.5 – 1 mM at rest to 10 mM during moderate physical exertion and exceeding the limit of 20 mM in case of more extreme conditions. This falls well beyond the linear range of many existing systems constituting therefore a major limitation in the field of diagnostic tools development.[2] In this work, we present a novel time-modulated sensing strategy based on a paper-based Pt semi-open electrochemical cell (SOEC) – developed in our group in previous works[3] – coupled with a charge-pump circuit. This latter comprises a switched capacitor system connected to the sensor's electrodes, programmed to alternatively move from open to closed circuit conditions. The vertical architecture of the SOEC sensor, resembling the structure of an electronic capacitor, allows for the generation and accumulation of electrochemical charge. By exploiting the pseudocapacitive nature of the sensor and regulating charge accumulation on its active surface over time, we demonstrate effective signal linearization across the high concentration range of hydrogen peroxide. This approach has been further validated through the direct detection of L-lactate at elevated levels with a

specifically biofunctionalized sensor, showcasing its potential for robust, high-range biosensing for clinical and wearable device applications.

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Topics

Electrochemical transducers

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Abstract Title:

Towards digital detection of biomarkers with CMOS ISFET arrays

Abstract body:

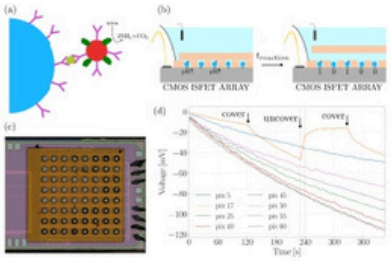
Digital biomolecular detection is transforming biosensing by enabling ultra-sensitive, single-molecule resolution for clinical diagnostics and biomedical research. Unlike traditional analog methods such as ELISA, digital detection [1] partitions samples into microcompartments, statistically containing zero or one target molecule, and uses binary signal analysis for precise quantification. However, most digital platforms rely on complex optical systems, limiting scalability and point-of-care applicability. This work explores the integration of digital detection with CMOS ion-sensitive field-effect transistor (ISFET) arrays, enabling an all-electronic, miniaturized biosensing platform.

Figure 1(a) illustrates the proposed assay based on the urease enzymatic reaction. It is carried out by mixing urease-coated magnetic microparticles (MMPs) with polystyrene microparticles (PMPs) in a solution containing the targeted biomarker. The PMPs act as detection labels, producing a pH increase in the solution.

The label detection, shown in Figure 1(b), is performed by a CMOS ISFET array, compartimentalized using a microwell structure integrated on the chip sufrace. If the microwells and PMP have similar sizes, only one PMP can fit into each well, ensuring binary detection of the labels. Subsequently, the microwells are covered with a PDMS lid to promote the accumulation of products. After a few minutes of pH increase within the wells, the sensing spots are rapidly uncovered so that the ISFETs are again in direct contact with the bulk solution, which remains at constant pH.

Figure 1(c) shows a 64-ISFET array, manufactured in a 65-nm CMOS process, with an SU-8 microwell structure. In figure 1(d), a 30-µm PMP functionalized with type-IX Jack bean urease was placed on pixel 17, which exhibited an abrupt pH decrease unpon uncovering the wells, while the rest of ISFETs remained unaffected.

These results demonstrate that digital detection assays could be performed using CMOS ISFET arrays, greatly reducing equipment costs and enabling ultra-high-sensitive portable platforms.



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Topics

Electrochemical transducers

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Abstract Title:

Towards Scalable and Green Fabrication of Flexible Biosensors for Sweat-Based Glucose and Lactate Detection

Abstract body:

Wearable technologies are revolutionizing health monitoring by enabling real-time, non-invasive detection of key biomarkers in sweat[1]. While recent advances have demonstrated biosensors with excellent selectivity, response time, and stability, integrating these analytical features with scalable, low-cost, and eco-friendly fabrication methods remains a major challenge. Direct laser writing (DLW) of laser-induced graphene (LIG) on both synthetic and sustainable substrates has emerged as a promising platform, offering cost-effective, chemical-free processing ideal for next-generation eco-conscious wearable biosensors[2,3,4].

Herein, findings from recent studies are presented, focusing on the DLW-based fabrication of LIG electrodes on flexible platforms, including polyimide and reinforced natural biopolymers. To enable efficient and high-performance detection of glucose and lactate, key biomarkers in sweat, various biofunctionalization strategies were explored, including the use of different mediators (e.g., Os redox polymers, Prussian Blue, and tetrathiafulvalene) and enzymes (glucose oxidase, lactate oxidase, and a novel lactate dehydrogenase).

Following optimization of both the LIG fabrication and biofunctionalization steps, the developed biosensors were evaluated for analytical performance. They exhibited high sensitivity, rapid response, and excellent selectivity for both glucose and lactate. Osmium redox polymers demonstrated a very low background current and high catalytic response for both biomarkers. The biosensors also showed remarkable stability and reproducibility, ensuring reliable performance. When comparing lactate biosensors with commercially available LOx and novel LDH enzymes, the latter exhibited the most efficient and stable response. The novel LDH, with its built-in cofactor, eliminates the need for external cofactors like NAD and is oxygen-independent, resulting in accurate responses even under low-oxygen conditions. Notably, the developed biosensors showed short-term operational stability (over 2 hours) and a shelf life of more than 6 months.

These findings demonstrate the potential of DLW-fabricated LIG biosensors as a scalable, eco-friendly solution for high-performance, non-invasive monitoring of glucose and lactate, offering promising prospects for wearable healthcare applications.

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Topics

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Abstract Title:

Valorizing G-quadruplex DNA Structures in Cancer Diagnosis and Staging through Accessible Electroanalytical Biodevices

Abstract body:

Although electrochemical biodevices have become leading tools for portable and wearable monitoring of emerging biomarkers, a substantial gap remains between laboratory research and actual clinical applications. In chronic diseases like cancer, the technology transfer of these innovative approaches is still a major unmet challenge. Bridging this gap requires disruptive strategies developed in close collaboration with clinicians, aiming to identify new biomarkers and enable their true clinical valorization. Only through this synergy can enabling technologies be implemented to support personalized and accessible cancer diagnosis and therapy [1]. Rising to the challenge of fulfilling these ambitious objectives, we continue to advance research into one of the least explored genetic cancer biomarkers through electrochemical strategies: non-canonical G-quadruplex (G4) DNA structures. These high-order, dynamic secondary structures strongly correlated with cancer initiation and proliferation. Moreover, their tunable stability has positioned them at the center of emerging therapeutic strategies, underlining their outstanding capabilities as multitasking biomarkers for precise cancer diagnosis and close tracking of therapeutic outcomes. Having pioneered the initial milestone of developing electroanalytical strategies for G4s detection in DNA at global level [2], we now face a greater challenge: proving their real-world applicability in the valorization of G4 motifs in cancer, through their successful analysis in genomic DNA extracted from paired solid biopsies and minimally invasive biological fluids, such as plasma, obtained from colorectal cancer patients at various stages of the disease. These results will enable us to establish distinctive signatures of the G4 motifs in colorectal cancer and define diagnostic cut-off values, bringing these multifunctional and long-underrated markers, as well as the innovative, portable, and cost-effective technology developed for their determination, closer to real-world clinical practice, positioning it as a transformative tool for truly democratized and precise oncology.

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[1]: Campuzano, S., Ruiz-Valdepeñas Montiel, V., Torrente-Rodríguez, R. M., Pingarrón, J. M. Bioelectroanalytical technologies for advancing the frontiers to democratize personalized desired health. Anal. Chem. 97(22) (2025) 11371-11381. [2]: Cabrero-Martín, A., Ruiz-Valdepeñas Montiel, V., Torrente-Rodríguez, R.M., Povedano, E., Velázquez-Gutiérrez, J., Garranzo-Asensio, M., Pingarrón, J.M., Barderas, R., Campuzano, S. An electroanalytical approach for advancing cancer diagnosis and therapy by tracking globally DNA G-quadruplex non-canonical structures. Anal. Chem. (submitted).

Topics

Electrochemical transducers

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Abstract Title:

Versatile Conductive Ink Formulations for Flexible, Wearable, and Edible Enzyme-Based Bioelectronics

Abstract body:

Conductive inks are used for the development of disposable electrochemical sensors. They trigger the possibility of building screen- or stencil-printed electrodes with similar efficiency with respect to solid electrodes. [1,2] In particular, biocompatible inks are formulated and stencil-printed on a flexible support that could be easily integrated within smart-devices for the continuous and minimally invasive monitoring of lactate and glucose. First, the conductive ink formulation has been optimized based on electrochemical and rheological measurements implemented within a multivariate analysis model. Afterwards, the active carbon electrode was modified with osmium redox polymers (ORPs) to establish an electronic connection with enzymes, since neither glucose oxidase (GOx) nor lactate oxidase (LOx) are able to directly transfer electrons. [3,4] Finally, both biosensors have been tested in model solution and sweat to determine the analytical figures of merit.

The latest evolution of enzyme-based amperometric biosensors is represented by edible biosensors that can now detect a variety of parameters, ranging from basic physiological measurements such as temperature and pH to complex analyzes of organic and biological gases, and provide the data in real time. They can monitor a wide range of biomarkers, including those related to gastrointestinal health, enzymes, hormones, glucose levels, and even drug concentrations. [5]

Abstract References

Acknowledgments We acknowledge financial support under the National Recovery and Resilience Plan (NRRP), Mission 4, Component 2, Investment 1.1, Call for tender No. 1409 published on 14.9.2022 by the Italian Ministry of University and Research (MUR), funded by the European Union – NextGenerationEU– Project "Title gReen analytical methods for PAHs detection in EVOO: from lABoratory to smart LabEl" (RELIABLE) – CUP H53D23007750001- Grant Assignment Decree No. 1386 adopted on 01/09/2023 by the

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Topics

Electrochemical transducers

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5th European Biosensor Symposium

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Abstract Title:

Web interface for electrochemical biosensors

Abstract body:

Introduction

Electrochemical measurements can be made more user friendly by combination with modern presentation options provided by web technologies. The common is control of the detectors using Bluetooth and smartphone. However, the combination with WiFi network allows to connect any device using universal web application running in browser and transferring data and commands with the detector in real time. The measuring system was made from "components of the shell" – modular potentiostat Emstat Pico running custom MethodScript protocol, and Xiao ESP32S3 microcontroller for data pre-processing, storage, WiFi network, and real-time graphical presentation using the embedded web page.

Results

Emstat Pico is programmed using the MethodSCRIPT protocol; amperometry was chosen, as most biosensors operate in this simplest mode. The rather complex data output from the module is linked to Xiao using serial interface and transformed to simple float numerical values. Xiao uses the LittleFS library for internal storage of web page (index.html), supporting javascript library (highchart.js) and ascii-based data (data.txt). The Xiao functions as a WiFi access point; when user connects to this network, the web page can be opened, the electrochemical protocol initiates and the measured values of current are graphically presented in real time using the web sockets protocol. The internally saved results can be downloaded. Another electrochemical protocol can be uploaded through the Xiao USB serial interface as a text file; this way, the working potential and timing interval can be modified. The relevant codes for programming the Xiao using the Arduino IDE will be presented, as well as the details of the web page construction, and initial evaluation using the classic glucose biosensor.

Conclusions

This contribution demonstrates simple straightforward approach to web presentation of electrochemical experiments for both research and education purposes.

Abstract References

Support from Ministry of Education of Czech Republic OP JAK project SENDISO no. CZ.02.01.01/00/22_008/0004596 is acknowledged.

Topics

Electrochemical transducers

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MICROFLUIDICS

ORAL COMMUNICATION

5th European Biosensor Symposium

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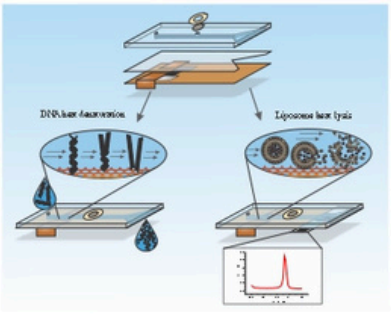
Abstract Title:

A Versatile Microfluidic Device with Integrated Joule-Heating and Bubble Trap for Enhanced Point-of-Care Biosensing

Abstract body:



Heating is a powerful tool for various (bio)-analytical and -chemical applications, not only influencing reaction speeds but also specificity and sensitivity. To-date, it is seldomly taken into consideration in the design of point-of-care (POC) settings as its hardware and power needs disregard it due to implied complexity. Furthermore, especially in microfluidic settings, bubble formation upon temperature rises remains a major challenge. Here, we present a low-cost, POC friendly microfluidic device featuring an integrated Joule-heating element and an efficient, instrumentation-free bubble trap. The Joule-heating element reliably generates temperatures up to 130°C using less than 9 V, making it ideal for battery-powered devices. Laser-induced graphene (LIG) as a material is quickly and inexpensively produced. Our novel bubble trap system, which operates without extensive external instrumentation, eliminates large gas volumes produced on-chip through a channel opening covered with hydrophobic nanofibers. This platform is very versatile, with the possibility of the integration of electrodes for electrochemical detection, second inlets and mixing elements. Targeted applications include liposome-based bioassays, eliminating the need for detergents via heat lysis, DNA

denaturation for sample preparation or amplification, and on-chip chemical synthesis of heating-dependent reactions like gold nanoparticle (AuNP) production.

Abstract References

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Topics

Microfluidics

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Enhanced performance of lateral flow devices by patterning microfluidic structures

Abstract body:

Background: Lateral flow tests (LFTs) are widely recognized for their simplicity, rapid operation, and cost-effectiveness, making them indispensable tools for point-of-care diagnostics. Despite these advantages, their sensitivity is frequently lower compared to laboratory-based methods such as enzyme-linked immunosorbent assays (ELISA), limiting their ability to detect biomarkers at low concentrations, an aspect crucial for early disease diagnosis.

Materials & methods: In this work, we report on a LFT-like device that significantly enhances the sensitivity of conventional LFTs by incorporating microfluidic structures designed to modulate fluid dynamics and increase the interaction time between sample and reagents. Multiple rapid prototyping techniques were employed to fabricate flow restrictors and channel architectures onto nitrocellulose paper, optimizing the fluidic pathway for improved assay performance. A comparative study was carried out with conventional and patterned LFTs using an immunoassay for the detection of interleukin-6 inflammatory biomarker as a model analyte. Both qualitative and quantitative detection approaches were assessed that are based on the use of detection antibodies conjugated to gold nanoparticles or horseradish peroxide enzymes for visual readout or electrochemical detection, respectively.

Results: The patterned device unambiguously enabled the detection of interleukin-6 at 100 pg/mL, a threshold that could not be achieved with the control LFT. These findings demonstrate that integrating tailored microfluidic structures into LFTs can substantially improve their sensitivity, paving the way for broader applications in early and accurate disease diagnostics.

Acknowledgements: The work has received funding from "la Caixa" Foundation under the project code HR23-00679.

Abstract References

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Topics

Microfluidics

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Abstract Title:

Enhanced-Specificity Point-of-Care Serological Testing with Microfluidic IgG Separation and Magnetically Assisted Immune Complex Detection

Abstract body:

Serological testing plays a key role in modern diagnostics of autoimmune diseases as well as bacterial, viral, and parasitic infections. By detecting pathogen-specific antibodies in serum or plasma, these assays provide safer, faster, and more accessible alternatives to conventional microbiological methods. Despite their wide application, especially in enzyme-linked immunosorbent assays, serological methods face persistent analytical challenges, including nonspecific adsorption of matrix components, high levels of endogenous immunoglobulins, and intrinsic peroxidase-like activity. These issues compromise sensitivity, specificity, and reproducibility, limiting broader implementation in automated and miniaturized solutions. Advances in microfluidic technologies, particularly flexible lab-on-a-foil systems, offer new opportunities for integrating sample preparation, reagent handling, and detection into compact, cost-effective diagnostic platforms that are easy to use at the point of care [1].

In this work, we present two complementary research threads that together address both the performance enhancement and simplification of serological diagnostics. The first thread focuses on improving detection tools by systematically identifying key sources of analytical interference in ELISA-type assays, using *anti*-nucleoprotein SARS-CoV-2 and *anti*-Helicobacter pylori antibodies as model targets. We intend to develop new assay formats that incorporate multifunctional magneto-catalytic nanosorbents, which enable magnetic separation of immune complexes, dual-specific recognition, suppression of endogenous redox activity, and robust signal generation in simple protocols with fewer steps [2]. The second thread aims to facilitate serological diagnostics through the design of an affordable, disposable microfluidic module for IgG separation. This lab-on-a-foil platform utilizes reversible binding of IgG to protein A/G immobilized on polyester films, achieving rapid, small-scale antibody isolation directly from serum within minutes [3]. The module is compatible with ELISA, lateral flow tests, and biosensors, and can be integrated into micro total analysis

systems for multiplexed serological profiling or selective antibody capture. These developments are intended to support more efficient and accessible serological testing in PoCT applications.

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Topics

Microfluidics

Porycka, Karolina[1]; Drozd, Marcin[1]; Tokarska, Katarzyna[1]; Żukowski, Kamil[1]; Rastawicki, Waldemar[2]; Pietrzak, Mariusz[1]; Malinowska, Elżbieta[1]

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Improving Lateral Flow Assay Performance through Hydrogel Integration

Abstract body:

Over the years, point-of-care diagnostics have shown great potential for replacing traditional methods of healthcare monitoring. The need for these platforms has been strongly emphasized during the COVID-19 epidemic for saving lives while enabling fast decision-making at low cost.1 The user-friendly and portable design allows the monitoring of target analytes within minutes and increases the chance of early diagnosis. Lateral flow assays (LFAs) are one of the most popular on-site testing tools for enabling fast and accurate results based on paper without the need for special equipment.2 These platforms are lightweight, disposable, and user-friendly compared to conventional laboratory-based methods that are commonly used for detecting biomarkers in complex biological samples such as blood, urine and saliva. However, nonspecific interactions caused by biomolecules reduce the biosensor performance and requires a need for pretreatment of the sample. In this work, we present a point-of-care biosensing platform based on hydrogel-integrated LFAs to improve sensor performance by controlling the flow and filtering the biological sample. Hydrogels are hydrophilic polymeric networks that have been used in many biomedical applications thanks to their physicochemical characteristics.3The nanoporous hydrogels allow size-selective filtration of biomolecules in the LFA and control the flow rate of sample for increased antibody-analyte binding time. Therefore, various hydrogels integrated into nitrocellulose to enhance the sensor performance have been investigated. The structure of the hydrogel in the nitrocellulose was characterized by SEM, confocal microscopy and filtering tests with analytes of known sizes.

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Microfluidics

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POSTER

5th European Biosensor Symposium

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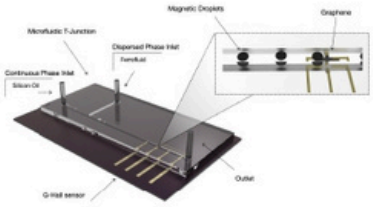
Abstract Title:

MNP-Based Microfluidic Communication Using Graphene Hall Sensor Receivers

Abstract body:

Molecular communication (MC) offers a transformative framework for transmitting information via chemical or physical carriers at the micro/nanoscale, with applications in both biological and synthetic environments. In this work, we introduce a non-biological MC system that employs a graphene Hall-effect (G-Hall) sensor as a nanoscale receiver, integrated within a microfluidic platform. Information is encoded by modulating the concentration of magnetic nanoparticles (MNPs) within droplets, which are routed through a PDMS-based T-junction channel and passed over the G-Hall sensor under a uniform perpendicular magnetic field. The sensor captures real-time Hall voltage signals, enabling time-domain detection of magnetically encoded information without the need for biochemical labels or reactions. This configuration establishes a robust, label-free, and scalable communication testbed, capable of supporting experimental exploration of channel behavior, concentration-based modulation schemes, and physical-layer signal decoding. By coupling microfluidics, advanced nanomaterials, and real-time electronics, the system lays a foundation for future integration into lab-on-chip devices and intra-body molecular networks. Its simplicity, reconfigurability, and compatibility with existing microfabrication workflows make it a compelling platform for investigating next-generation communication architectures within the Internet of Bio-Nano Things (IoBNT). A schematic of the integrated setup is shown in Figure 1(attached), highlighting the droplet path and sensor configuration.



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Microfluidics

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ORAL COMMUNICATION

5th European Biosensor Symposium

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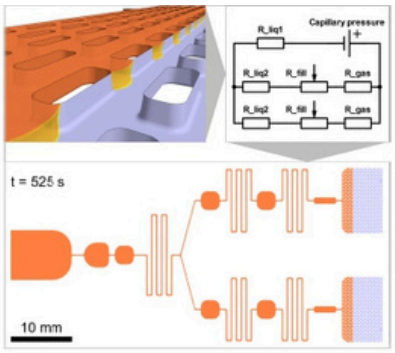
Abstract Title:

Modelling of capillary-force-controlled microfluidic systems using multiscale simulation methods

Abstract body:

Miniaturised point-of-care (PoC) biosensors integrate microfluidic architectures with microelectronic interfaces to enable rapid diagnostic analysis while requiring minimal sample and reagent volumes [1]. Utilising capillary force is a widely adopted method to induce fluid transport without involving any active components or external power [2]. In the absence of auxiliary equipment such as mechanical micropumps, flow is passively modulated by geometry and surface features of a Lab-on-a-Chip (LoC). Integrated assay workflows, however, can require precise fluid handling [3], hence motivating the use of simulation-based design methods. While computational fluid dynamics (CFD) can be utilised to calculate flow characteristics within a LoC, it is limited by systemic complexity comprising multiple interacting microfluidic elements [4]. Thus, it is generally not suited for efficient prediction of system-level behaviour. Lumped-element methods applying analogies between electric and hydraulic circuits have gained attention in recent years but rely on highly abstracted descriptions of the system components [5].

We propose a multiscale method combining CFD simulations and lumped-element modelling – integrating accurate physical descriptions into system-level representations. To this end, 3D models of the channel and chamber structures are developed based on detailed geometric and surface data. These highly detailed models account for surface properties and shape deviations inherent in the manufacturing process. Solving these fluid mechanical models yields the hydrodynamic properties of each component of the LoC, i.e., spatial descriptions of hydraulic resistances and capillary pressures. Subsequently, these properties are linked according to the network topology of the entire microfluidic system, using an electric circuit analogy. The developed LoC model allows the precise calculation of fluid movement both at the system level and within individual components. This multiscale modelling approach enables the rapid evaluation of design adaptations of capillary-force-controlled LoC with respect to the arrangement and interconnections of its components.



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Microfluidics

Loebel, Sascha[1]; Schaarschmidt, Ingo[1]; Steinert, Philipp[1]; Gärtner, Eric[2]; Pöhlmann, Christopher[3]; Hein, Marko[3]; Richter, Martin[3]; Weitzenberg, Jörg[3]; Eckert, Udo[2]; Schubert, Andreas[1]
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Abstract Title:

Monitoring astrocyte response to ischemia via GFAP impedimetric sensing in a Stroke-on-a-Chip Model

Abstract body:

Organ-on-a-chip platforms provide physiologically relevant models that mimic human tissue architecture and function, making them powerful tools to study its physiological and pathological conditions. In stroke modeling, these systems offer tunable platforms to understand ischemic and hemorrhagic processes and recovery strategies. However, continuous monitoring of stroke biomarkers is still limited, mostly relying on imaging techniques. Monitoring protein release by these systems would be an ideal approach, providing critical insights into cellular responses, inflammation, and tissue damage.

Here, we combined a 3D stroke organ-on-a-chip with an impedimetric immunosensor for GFAP (glial fibrillary acidic protein), a key marker of astrocyte activation and death, enabling a simple monitoring in these models. Ischemic conditions were first optimized in 2D by exposing human astrocytes to various culture conditions mimicking brain hypoxia. These were then adapted to a 3D organ-on-a-chip based on a previously described microvascular system [1], comprising an astrocyte-laden collagen hydrogel with a lumen connected to the device inlets and outlets. The model showed hallmark features of ischemic injury, including a substantial drop in viability under stroke conditions.

The developed electrochemical sensor achieved a detection limit of 2 pg/mL and a quantification limit of 10 pg/mL for GFAP, enabling sensitive detection of protein release into the culture medium. GFAP levels measured by the sensor were in correlation with intracellular GFAP detected by immunofluorescence, confirming astrocyte activation and injury under stroke conditions.

This platform establishes a solid foundation for studying ischemic responses in vitro, integrating functional biomarker monitoring beyond traditional imaging approaches, and paving the way for real-time evaluation of neuroprotective strategies.

Acknowledgments: This research was funded by I+D+i projects PID2023-148375OB-I00 and IDE/2024/000694 (funded by MCIU/AEI/10.13039/501100011033/FEDER-EU and PCTI Program, Government of the Principality of Asturias, and the FEDER-EU respectively). P.R.L. acknowledges support from the Asturian Council for Science, Technology, and Innovation ("Severo Ochoa" grant BP21-029).

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Topics

Microfluidics

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

New automation and detection strategies for compact biomarker monitoring systems based on microfluidic microarrays

Abstract body:

Accurate continuous quantification of protein biomarkers at the point of need is required in different applications, such as patient monitoring and organ-on-chip systems[1] . Cytokines, in particular, serve as inflammation-related physiological biomarkers of immune response[2-5]. Conventional quantification methods like ELISA, despite widely used, are hampered by high sample volume requirements and lack of automation[6]. To address these limitations, this research work focuses on developing a compact microfluidic platform capable of automating the immunoassay workflow for cytokine detection using minimal (µl) sample volumes[7]. To this purpose, manual handling is avoided, enabling plug-and-play integration in a laboratory environment.

A polymer-based microfluidic platform is designed for reagent injection, mixing and incubation. A PDMS chamber is closed against the glass microarray surface, enabling direct immunoassay execution on the spots. Fluid management is regulated via miniature pumps, valves and sensors, all managed through LabVIEW software. Fluorescence read-out is selected as biomarker detection technique.

A functional microfluidic prototype has been developed and validated for a sandwich immunoassay protocol targeting Interleukin-6. The microarray comprises 21 areas with 36 spots each, allowing multiple daily analyses. Fluorescence detection using TRITC demonstrates successful bonding and signal acquisition, detecting the presence of the cytokine.

These results prove the feasibility of a compact, automated immunoassay configuration, maintaining low-volume requirements. This research paves the way for potential multiplexed biomarker detection in a plug-and-play biosensing platform.

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Topics

Microfluidics

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Abstract Title:

Programmable heating for fluorescence microscopy using Printed Circuit Board (PCB) technology

Abstract body:

Precise temperature control is a powerful yet often neglected tool in fluorescence microscopy for studying biomolecular kinetics and thermodynamics. Current heating methods are typically limited by poor temporal resolution, high costs, or technical complexity. To address these limitations, we introduce a low-cost, flexible Printed Circuit Board (PCB) platform that enables rapid and programmable temperature modulation directly at the sample plane. Using software-controlled Joule heating, this system supports both conventional temperature-jump experiments and dynamic thermal perturbations inspired by analog electronics. For example, wave modulation, chirp signals, and frequency filtering enable frequency-domain analysis of molecular relaxation processes.The platform's customizable design and commercial availability make advanced thermal control more accessible for both ensemble and single-molecule experiments.

Abstract References

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Topics

05 Microfluidics -

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5th European Biosensor Symposium

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Abstract Title:

Surface Modification of PDMS-based Micro- and Nanofluidics with Polymer Brushes via SI-ARGET ATRP

Abstract body:

Background

Poly(dimethylsiloxane) (PDMS) is commonly used in micro- and nanofluidics for its fabrication ease and biocompatibility1. However, its hydrophobic surface causes unwanted air bubbles and biomolecule adsorption. A feasible solution is using polymer brush (PB) coatings synthesized via Surface Initiated Activators Regenerated by Electron Transfer Atom Transfer Radical Polymerization (SI-ARGET ATRP). This technique employs sequential aqueous monomer polymerization using low copper concentrations, with ascorbic acid regenerating active Cu(I) species2. The resulting PBs improve flow stability and reduce biofouling, enhancing device reliability and creating a robust biointerface framework for integration of functional assays in biosensing platforms.

Materials & methods

Master molds for fluidic polymerization chambers (FPC) were created using SU-8 photolithography. PDMS replicas were bonded to gold substrates, which served as reference surfaces for polymerization due to challenges in PDMS characterization. Following the surface functionalization with initiator-terminated self-assembled monolayers, an ARGET polymerization solution was introduced (Fig.1).

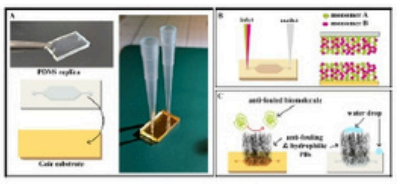

Figure 1. The synthesis of PBs on the surfaces of micro- and nanofluidics. (A) Assembled FPC (B) By flowing a mixture of monomers through the FPC, a homogeneous mixture of monomers is obtained. (C) Anti-fouling and hydrophilic PBs.

Results

Preliminary surface characterization confirms the successful immobilization of the initiator and the growth of the PB. An increase in surface hydrophilicity by contact angle measurements indicates surface modification of PB. Infrared and XPS spectra show the presence of characteristic signals from the PB. A comprehensive analysis of brush morphology, variation in thickness, and functional performance, such as reduced biofouling and improved flow stability, will be presented at the conference.

Conclusions

SI-ARGET ATRP allows for the synthesis of tunable PB coatings on PDMS-based fluidic devices using low copper catalyst concentrations. This approach shows promise for enhancing device reliability and biointerface performance. Ongoing research will focus on long-term stability, biological compatibility, and biosensor integration of functional assays.

Abstract References

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Topics

Microfluidics

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Tracking and Characterizing Cells in Real Time with Microfluidic Impedance Cytometry

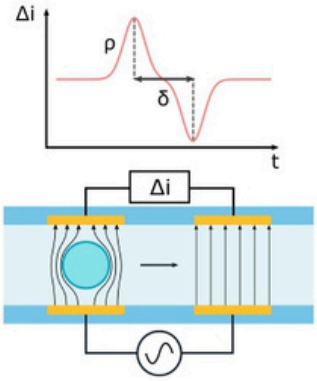
Abstract body:

Microfluidic single cell analysis is becoming an important tool for Lab-on-Chip devices [1]. While traditional flow cytometry offers high throughput, it relies on fluorescent labelling. Impedance Cytometry (IC) is a promising label-free alternative which measures the dielectric properties of cells in flow, making it easily integrated in larger Lab-on-Chip devices [2]. This works aims to use IC for characterization and real time tracking of cells. Some efforts have already been made toward measuring the position of cells [3]. However, continuous positional monitoring remains a challenge, which this work seeks to address.

The device consists of a straight SU-8 microfluidic channel (⌀ = 30 µm). Along the channel, multiple sets of gold electrodes are deposited on a glass substrate in a facing configuration. By applying an AC signal to the bottom electrode set, a differential current is measured resulting in a bipolar Gaussian peak as beads pass through the device channel. Parallel to the fabrication, device modelling is carried out in COMSOL Multiphysics®.

Preliminary results show a correlation between particle and position with peak height ρ, and particle velocity with and peak spacing δ. Next experiments will study whether it is possible to predict future position of the beads along the channel. We will compare both simple extrapolation methods and advanced time series prediction algorithms which uses data from multiple passing beads to dynamically tune the extracted velocity profile. The prediction model will be validated by comparing it to an optical reference and/or other impedance sensing regions further along the channel.

The technique will provide the bases for more advanced Lab-on-Chip devices which require cell tracking without the need for traditional optical methods, while simultaneously extracting biophysical single cell properties.



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Topics

Microfluidics

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OPTICAL TRANSDUCER

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Abstract Title:

A simple, adaptable, modular SPR-imaging device with open architecture for biosensor research.

Abstract body:

Background:
Many commercial SPR instruments lack adaptability, limiting researchers in customizing experimental setups or integrating new sensor materials and fluidic components. This inflexibility can impede method development and slow scientific progress 1. To address these challenges, we have developed a modular SPR-imaging device with fully standardized mechanical, electronic, and fluidic interfaces 2. By adopting an open architecture and widely available connection standards, our system enables users to exchange and upgrade all key components with ease. This approach supports rapid prototyping, efficient troubleshooting, and flexible adaptation to a wide range of experimental requirements, fostering innovation and versatility in SPR-based research.

Materials & Methods:
The device employs standardized M12 connectors for all electronic interfaces and USB3 Vision for camera integration. Optical components are mounted using industry-standard 30 mm, 40 mm, or 60 mm cage systems. The SPR prism and flow cell are positioned on an exchangeable rail system. All control protocols are openly documented, supporting user-driven hardware and software customization.

Results:
The modular SPR device achieved sensitivity and reproducibility comparable to established commercial systems. Users could quickly replace sensor chips, flow cells, optical elements, cameras, and electronic modules without specialized tools. Standardized interfaces—M12 for electronics, USB3 Vision for cameras, and cage systems for optics—ensured seamless integration of custom or third-party components. The rail system enabled rapid exchange of SPR chips and flow cells. Beta testers reported reduced downtime and enhanced flexibility for method development. This open, modular approach allowed straightforward adaptation

to diverse experimental needs, significantly lowering barriers for innovation and supporting efficient experimental workflows.

Conclusions:
The open architecture and standardized interfaces of this SPR instrument empower users to freely customize and upgrade all components. This design lowers technical barriers, fosters innovation, and enables rapid adaptation to evolving research needs, providing a new level of flexibility and efficiency for the SPR community.

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Topics

Optical transducers

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FLASH PRESENTATION

5th European Biosensor Symposium

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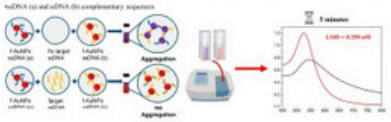
Abstract Title:

A user-friendly and rapid colorimetric biosensor for environmental DNA detection

Abstract body:

Over the past decade, environmental DNA (eDNA) has emerged as a promising tool for studying biodiversity, utilizing genetic markers to deduce the presence of various species.[1] Currently, eDNA detection is carried out using different approaches based on the use of Polymerase Chain Reaction (PCR), but this technique is expensive, time-consuming and requires specialized personnel. In this scenario, it is highly desirable to develop a rapid colorimetric biosensor, which can also be employed for real-time analysis. Building on our prior expertise,[2] we propose an approach based on the competitive and specific aggregation of gold nanoparticles (AuNPs) induced by the absence of the target (eDNA). To this aim, we synthesize two distinct batches of functionalized gold nanoparticles (f-AuNPs), each having a different and complementary single-stranded DNA (ssDNA) sequence. In the absence of the target analyte, mixing the two batches of f-AuNPs together will result in aggregation due to the interaction between their complementary ssDNA sequences. On the contrary, aggregation will not be visible when the target analyte is recognized by one of the two batches of f-AuNPs. This technique was used to detect the ssDNA target sequence specific to *Fusarium oxysporum* in ultrapure water. The results are encouraging we achieved a limit of detection (LOD) of 0.250 nM (1.5×10^{-3} ng/µL) for the target ssDNA, with a detection time of only 5 minutes. Furthermore, when applied to soil-derived samples, the technique produced comparable results to those obtained in ultrapure water.[3]

Thus, we present a user-friendly, quantitative, and low-cost method for *F. oxysporum* detection. It is rapid, easy to use, and does not require trained personnel. With appropriate sequence modifications, this system can be readily adapted to detect a wide range of species.



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Topics

Optical transducers

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5th European Biosensor Symposium

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Abstract Title:

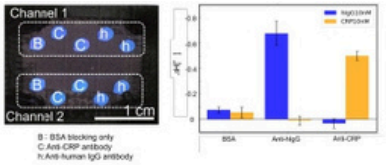
Colorimetric Plasmonic Biosensor for the Parallel Detection of Multiple Biomarkers

Abstract body:

To date, portable plasmonic biosensors for on-site applications have seen rapidly expanding demand in healthcare, food safety, and environmental monitoring. Thanks to their outstanding sensitivity and adaptable optical designs, these platforms are well positioned to drive progress in mobile biosensing. We have developed spectrometer-free, colorimetric biosensors employing color-generating plasmonic metasurfaces, achieving direct detection of biomolecules—including cancer biomarkers—at sub-nanomolar levels [1,2]. In this contribution, we present the fabrication process of the plasmonic metasurfaces used as sensor substrates and the fundamental sensing characteristics of the colorimetric plasmonic biosensors employed for multiplexed biomarker detection, specifically inflammation marker, c-reactive protein (CRP).

A silver nanodome array consisting of a thin metal film deposited on a polystyrene (PS) nanoparticle was used as the plasmonic metasurface of the sensor substrate. The fabricated sensor substrates were functionalized with the capture antibody for the target molecule via polydopamine linker layer, followed by the blocking agent. The, the color change of the sensor substrate before and after binding of the target molecule was measured from the reflection images. The color of the sensor spot was assessed using the hue angle of the HSV color space coordinates.

Firstly, direct detection of CRP at a single spot was performed to determine the limit of detection (LOD). The LOD for CRP in buffer was 0.13 nM. Next, we patterned multiple sensing spots using a deposition mask, each modified with anti-CRP, anti-human IgG, or bovine serum albumin (BSA) as shown in the figure. Signals from the IgG- and BSA-coated spots served as controls. The sensor signals from each sensing spots shows the selectivity of the anchored antibodies. The LOD for CRP in the multiplexed detection format was determined to be 0.65 nM—slightly lower than that of the single-spot measurement, yet still below the clinical threshold.



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Topics

Optical transducers

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5th European Biosensor Symposium

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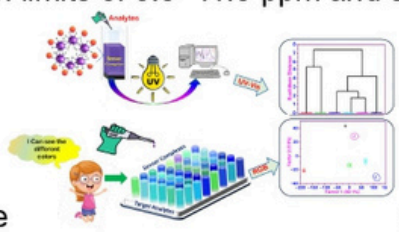
Abstract Title:

Colorimetric Sensor Arrays Integrated with Machine Learning for Comprehensive Detection of Toxic Analytes in Food and Environment

Abstract body:

Ensuring food safety and environmental health has become increasingly critical due to widespread contamination by harmful substances such as biogenic amines, mycotoxins, thiols, pesticides, and herbicides. These contaminants, often introduced at various stages from crop cultivation to storage and processing, pose significant risks to public health and food quality. To address this challenge, we have developed a series of advanced, machine learning-integrated colorimetric sensor arrays utilizing hierarchically engineered nanomaterials and azodye-based metal complexes for on-site detection and discrimination of hazardous analytes in complex matrices. In this regard, a surface-engineered metal oxide-based sensor array functionalized with azodye-metal complexes was successfully developed for rapid, on-site detection of mycotoxins in corn. It exhibited excellent sensitivity with detection limits between 0.02–0.09 ppm and 100% discrimination accuracy for multiple mycotoxins, including complex mixtures, confirming its practical applicability through LDA analysis. Similarly, metal-ion-decorated organic nanoparticles enabled selective and sensitive detection of biologically relevant thiols with detection limits between 1.19 and 4.20 μM. The sensor array, supported by LDA and HCA, accurately differentiated target thiols, demonstrating its potential for biomedical and food safety applications. Additionally, a versatile azodye-based chromogenic sensor array was established for detecting and distinguishing pesticides and herbicides in food and soil. Enhanced by metal-ion interactions and multivariate machine learning models (LDA, PCA, HCA, PLSR), the system achieved high

accuracy with detection limits of 5.3–11.8 ppm and strong linear correlations (R^2 = 0.89–0.96), including effective binary mixture  analysis.

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Topics

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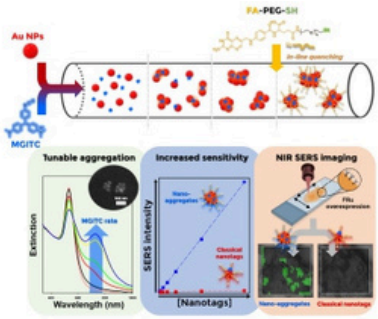
Abstract Title:

Controlled aggregation of gold nanoparticles in continuous flow microreactor: toward the robust production of ultrasensitive NIR SERS nanotags

Abstract body:

Surface-Enhanced Raman Scattering (SERS) nanotags are powerful tools for bio-analytical applications owing to their spectral specificity and detection sensitivity [1]. Achieving strong SERS signals requires the generation of intense electromagnetic hot-spots, which are typically formed within closely spaced plasmonic nanoparticles, making the design of well-controlled nano-aggregates a promising approach for enhancing sensitivity [2]. This study demonstrates a flow chemistry approach for the controlled production of gold nano-aggregates optimized for Surface-Enhanced Raman Scattering (SERS) under near infrared (NIR) excitation. Using a two-stage microreactor system, 30 nm gold nanoparticles (Au NPs) are aggregated in a controlled manner with MGITC, then aggregation is rapidly quenched using HS-PEG-COOH or HS-PEG-Folic Acid (FA) to stabilise the nano-aggregates. Systematic variation of MGITC flow rate and reactor residence time enabled tunable aggregation, as confirmed via UV-Vis spectroscopy, DLS, and SERS. The setup also offered high reversibility, with on-demand switching between aggregation states during the reactor operation. The best performing nano-aggregates provided over 100-fold SERS sensitivity improvement compared to non-aggregated Au NPs. Aggregation quenching with HS-PEG-FA provided additional targeting capabilities, enabling the complete production of nano-aggregates able to target cancer cells overexpressing folate receptors. In cancer tissue imaging experiments under 785 nm excitation, the nano-aggregates provided high-contrast SERS maps, while classical non-aggregated Au tags failed to generate detectable signals. Our platform offers on-demand production of tailored, ultrasensitive SERS tags suitable for biomedical imaging and diagnostics, combining enhanced signal strength and biological specificity.



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Topics

Optical transducers

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Abstract Title:

Design and development of Biocatalysis-induced plasmonic nanoparticle etching based fiber optic immunosensor

Abstract body:

This study highlights the design and development of a novel, sensitive biosensor based on the enzyme-mediated etching of silver nanoparticles (AgNPs), immobilized on a 'U-bent' fiber optic probe. The sensor is designed and optimized for the detection of Human Immunoglobulin G (HIgG), utilizing the sandwich ELISA approach, where the immunocomplex was developed on the immobilized AgNPs. In this sensing scheme, Goat anti-human immunoglobulin G (GaHIgG) and horseradish peroxidase (HRP) conjugated GaHIgG were used as capture and detector antibodies respectively. In the presence of the target, the immunocomplex formed and the HRP-tagged antibody catalyzed hydrogen peroxide-mediated oxidation of 3,3'5,5'-tetramethylbenzidine (TMB) to TMB^{+} and later TMB^{2+} by protonation. The TMB^{2+} causes the oxidative etching of AgNPs immobilized on the fiber optic probe which leads to a decrease in absorbance intensity at 430 nm, i.e. the characteristic absorption maxima of AgNPs, and this measurable change enabled the quantification of HIgG at low concentrations. The limit of detection of the developed sensor found to be 50 ag/mL (33.3 zM) with a good linearity ranging from 100 fg/mL (666.7 aM) to 1 µg/mL (6.67 nM). Moreover, this platform can be readily adapted to detect a broad spectrum of analytes through modification of the recognition elements, providing a versatile tool for diverse future biosensing applications.

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Topics

Optical transducers

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5th European Biosensor Symposium

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Abstract Title:

Fluorescent Sensing of Neurotransmitters with Nanosensors: Interplay between Biofunctionalization and Kinetics

Abstract body:

Biohybrid interfaces based on functionalized nanomaterials, such as single-walled carbon nanotubes (SWCNTs) are powerful biosensors for small molecules. [1] By tailoring the SWCNT surface with biomolecules like DNA, highly sensitive sensors can be engineered that fluoresce in the beneficial near infrared (NIR) tissue transparency window.
For real-time bioimaging and biosensing applications, a comprehensive understanding of the sensor–surface interactions and the underlying kinetics is essential. [2] While much research has focused on sensitivity and selectivity, the kinetic aspects remain underexplored. Here, we demonstrate how different DNA modifications of SWCNT surfaces affect binding behavior and kinetics for various neurotransmitters.
We measure and report for the first time the rate constant of DNA modified SWCNT-based sensors for the important neurotransmitter dopamine using single nanosensor / single molecule measurements. [3] For this purpose, we image DNA modified (6,5)-SWCNTs nanosensors immobilized on glass surfaces and optically excite them to detect their NIR fluorescence emission at 980 nm. Single molecule traces show association and dissociation of single neurotransmitters, which enables measuring of rate constants (koff) by analyzing the dwell times of binding states. We find that different DNA modifications of the SWCNT change the rate constants, which can be exploited for selective sensing and bioimaging. Additionally, we quantify the heterogeneity of single sensor responses and give insights in binding modes.
In summary, we report the kinetics of neurotransmitter nanosensors, which is an important contribution towards quantitative neurotransmitter detection and imaging.

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A. Hagemann, S. Kruss, Kinetic Requirements for Spatiotemporal Chemical Imaging with Fluorescent Nanosensors, ACS Nano 11 (2017) 4017–4027. https://doi.org/10.1021/acsnano.7b00569. [3] Gretz et al. in preparation

Topics

Optical transducers

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POSTER

5th European Biosensor Symposium

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Abstract Title:

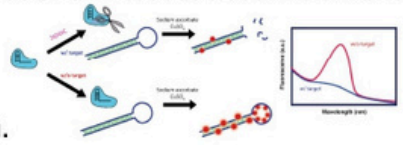
Highly sensitive pathogen DNA detection using CRISPR/Cas12a as receptor and highly fluorescent DNA-templated copper nanoclusters as optical transducers

Abstract body:

Early detection of pathogens is essential to ensure global health security, emphasizing the urgent need for affordable, rapid, and user-friendly assays [1]. In this context, CRISPR/Cas12a-based assays have emerged as promising tools, offering high sensitivity, specificity, and easy integration into (Point of Care) PoC devices [2]. On the other hand, DNA-templated copper nanoclusters represent a low-cost alternative to conventional organic fluorophores, owing to their remarkable properties, which include environmentally friendly synthesis, high photostability, and large Stokes shift [3].

In this work, we developed a detection assay based on the trans-cleavage activity of the Cas12a/crRNA complex. Upon recognition of the target pathogenic DNA, the activated complex cleaves the single-stranded loop regions of a rationally designed DNA sequence used to template copper nanoclusters, resulting in a measurable decrease in fluorescence intensity (Figure 1).

To optimize the assay performance, various DNA-copper nanocluster templating sequences were investigated, alongside the evaluation of different template concentrations and digestion times to maximize fluorescence signal reduction. The obtained results, together with perspectives on future clinical applications, demonstrate the potential of this novel method as a low-cost, rapid, and specific approach for pathogenic bacterial DNA detection.



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Topics

Optical transducers

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Abstract Title:

Hybrid Magnetic Nanozymes for Signal-Enhanced Biosensing

Abstract body:

Coupling magnetic and catalytic nanoparticles into a single nanostructure creates a versatile platform with tunable functionality for bioanalytical applications [1]. In this work, we present hybrid magnetic-core nanozymes designed to improve biosensor performance by enabling both simple analyte separation and signal amplification. The magnetic core provides easy manipulation using external magnetic fields, facilitating rapid isolation from complex samples. The catalytic surface exhibits peroxidase- or oxidase-like activity, supporting colorimetric, electrochemical, and optical detection strategies.

The magnetic cores were synthesized from iron and cobalt precursors using co-precipitation and hydrothermal methods. Their surfaces were decorated with highly catalytically active noble metal nanoislands. The core nanostructures were characterized using scanning electron microscopy, spectroscopy (UV-Vis-NIR, FT-IR), catalytic activity tests, and magnetometric measurements. Depending on the synthesis conditions, nanoparticles with different morphologies, sizes, and magnetic properties were obtained.

In the next step, the particles were coated with a polyphenol-based shell formed through nanozyme-driven polymerization. The properties of the resulting hybrid nanostructures varied depending on the type of polyphenol used and the polymerization conditions, such as pH and oxidizing agent. The modified particles exhibited enhanced absorbance in the visible and near-infrared regions, supporting potential applications in optical biosensing. These properties make them suitable candidates for surface plasmon resonance (SPR)-based detection systems. Catalytic activity tests confirmed the platform's ability to generate both colorimetric and electrochemical responses and an abundance of functional moieties allows for conjugation with bioreceptors.

This modular design allows tailoring of the nanozyme system for specific applications, ranging from biomedical diagnostics to environmental monitoring. The combination of magnetic handling, catalytic activity,

and optical properties provides a flexible foundation for next-generation biosensors that integrate sample preparation, signal amplification, and detection in a single system.

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Topics

Optical transducers

Górniaszek, Jan; Lapitan, Lorico Jr.; Trzaskowski, Maciej; Wróblewski, Rafał; Pietrzak, Mariusz
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Abstract Title:

Label-free vancomycin monitoring in serum with a hydrogel-based surface plasmon aptasensor

Abstract body:

Background :

Vancomycin (VCM) is a potent antibiotic with a narrow therapeutic window, requiring precise dosing to avoid toxicity or treatment failure. Conventional monitoring methods involve intermittent blood sampling, which limits temporal resolution and responsiveness to rapid concentration changes. This can result in suboptimal dosing and compromised patient outcomes. There is a clinical need for real-time, continuous monitoring systems that are accurate, selective, and functional in complex biological matrices such as human serum. To meet this need, we developed a hydrogel-based surface plasmon aptasensor capable of label-free, real-time vancomycin detection directly in undiluted serum.

Materials & Methods:

The sensor employs a long-range surface plasmon resonance (LRSPR) platform integrated with an MPC–MAT hydrogel layer for peptide aptamer immobilization. VCM-specific aptamers on a gold surface enable selective binding. Reflectivity changes are monitored to quantify VCM concentrations without the need for rinsing between measurements.

Results:

The aptasensor achieved a dynamic detection range of 60 nM to 100 µM for VCM in 100% human serum. The hydrogel design improved antifouling properties and enhanced sensitivity, yielding a 13-fold increase compared to non-hydrogel-based LRSP sensors. The sensor demonstrated high selectivity for VCM over other serum components and maintained stable performance, with a coefficient of variation of 6.5% across ten replicates. Real-time measurements were continuous, with rapid response to concentration changes and no signal degradation during extended monitoring, eliminating the need for rinsing or sensor regeneration between cycles.

Conclusions：

This hydrogel-based LRSP aptasensor enables accurate, real-time, label-free monitoring of vancomycin in serum. Its high sensitivity, selectivity, and stability suggest strong potential for clinical application in personalized antibiotic dosing, supporting safer and more effective therapeutic management in critically ill patients.

Abstract References

None

Topics

02 Optical transducers -

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Abstract Title:

Lighting the Future of Biosensing with Next-Generation Luminescent Proteins

Abstract body:

Luminescent proteins (LPs) are a powerful bioanalytical tool with significant potential, increasingly adopted in next-generation biosensors due to their unique photochemical properties.[1] Unlike traditional organic-based fluorochromes, LPs are highly stable and genetically customizable, enabling their spectral features to be tailored to the specific needs of the analytical system. Additionally, their recombinant production allows for fusion with molecular recognition elements—such as mimotopes and recombinant antibody fragments—selected through genetic engineering techniques like phage display.

Based on this technology, our research designs biosensor platforms where mimotopes, protein receptors, and recombinant antibody fragments are genetically fused with fluorescent proteins such as EmGFP,[2] YFP,[3] sfGFP,[4] or mScarlet-I.[5] These modular constructs enable highly sensitive detection of clinically and toxicologically relevant targets, including immunophilin-drug complexes (tacrolimus, rapamycin)[6] and mycophenolic acid, as well as mycotoxins like fumonisin B1 or HT-2 toxin in samples ranging from whole blood and oral fluids to food matrices like wheat, oats, and vegetable oils. The developed systems show excellent analytical performance and are easy to operate, making them suitable for real-world use.

To overcome external excitation and background fluorescence limitations in luminescent systems, we advanced bioluminescent platforms using cutting-edge luciferases as optical reporters and tracers. Using *NanoLuc luciferase*[7,8] and *Gaussia luciferase*,[9] we designed recombinant fusion proteins with mimotopes from phage libraries, enabling, for example, the implementation of homogeneous "mix and measure" assays that eliminate washing and chemical conjugation steps. These biosensors reach detection limits below ng/mL in clinical samples and food, producing highly intense signals with minimal background noise, thus enhancing their usability in real-world applications.

In short, luminescent proteins are key to creating fast, accurate, portable, and ethical biosensing systems for decentralized clinical diagnosis and global food safety.

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Topics

Optical transducers

Benito-Peña, Elena; Glahn-Martínez, Bettina; Pradanas-González, Fernando; Peltomaa, Riikka; Luque-Uría, Álvaro; García-Cortés, Marta; Navarro-Villoslada, Fernando; Orellana, Guillermo; Moreno-Bondi, María Cruz
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Abstract Title:

Long-period fiber gratings coupled with polymers for biosensing

Abstract body:

Optical fiber gratings—particularly long-period fiber gratings—are increasingly being employed in chemical and biochemical sensing applications that rely on detecting changes in surface refractive index (RI) through label-free configurations [1]. Due to their unique structure, the transmission properties of light in these gratings are influenced by RI variations in the surrounding medium, enabled by the presence of an evanescent field that extends several hundred nanometers beyond the fiber surface.

By functionalizing the fiber surface with a biolayer containing a biological recognition element selective to a specific target, it becomes possible to monitor RI changes resulting from specific biochemical interactions between the target and the biolayer [2]. This same principle can be applied to investigate the deposition or growth of hydrogels and polymers on the fiber surface, including innovative soft molecularly imprinted polymers based on the endogenous neurotransmitter serotonin [3].

These sensitive and versatile fiber optic systems have also enabled detailed characterization of polyacrylamide-based hydrogel deposition [4], which serves as a porous matrix for immobilizing antibodies and aptamers aimed at capturing bacteria.

The integration of this optical fiber sensor into a thermally stabilized closed-flow cell combines the advantages of the studied polymers and hydrogels with the inherent benefits of fiber optic sensing—namely, versatility, low cost, portability, and remote sensing capabilities.

Acknowledgements

We acknowledge financial support under the National Recovery and Resilience Plan (PNRR), Mission 4, Component 2, Investment 1.1, Call for tender No. 104 published on 2.2.2022 by the Italian Ministry of

University and Research, funded by the European Union – NextGenerationEU– Projects 202259W5FY_PE4_PRIN2022 Point-Of-Care electroanalytical platform for the detection of bacteria and antibiotic resistance – CUP B53D23013430006, 2022JRKETK_PE7_PRIN2022 Versatile hybrid in-fiBer Optical-electrocHemical systEMs for wIdely Applicable biosensing – CUP B53D23002670006 and P20227PWE5.PE4 PRIN2022PNRR Discovering the SEcret woRld of pOlyseroTONin for green molecular ImprINting and its application in bioanalytics – CUP B53D23025260001

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Topics

Optical transducers

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ORAL COMMUNICATION

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Abstract Title:

Magnetic beads-enhanced surface plasmon resonance imaging detection of circulating tumour DNA from cancer patients in liquid biopsy

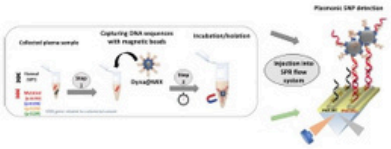
Abstract body:

Background: Detecting biomarkers in liquid biopsies is crucial for early cancer diagnosis, personalized therapy, relapse management, and improving survival rates. Conventional biomarker analysis protocols involve complex sample handling and time-intensive pre-analytical steps, including analyte extraction, purification, and isolation [1]. Surface plasmon resonance offers a promising real-time dynamic biomarker monitoring technology in liquid biopsy [2]. Thanks to their highly active surfaces and excellent chemical stability, superparamagnetic particles can be efficiently utilized as magnetic enhancers for ultrasensitive signal transduction [3]. We propose a superparamagnetic particle-enhanced SPR imaging biosensor for detecting single-point mutations in circulating tumor DNA by liquid biopsy [4].

Materials & methods: Peptide-nucleic acid (PNA) probes were specifically designed to distinguish between mutated and wild-type DNA. These PNA probes were attached to a gold surface via a microfluidic device integrated with a plasmonic sensor, allowing hybridization with both complementary and non-complementary DNA targets based on single-nucleotide mismatches.

Results: Superparamagnetic beads modified with biotinylated oligonucleotides directly captured normal and mutated DNA sequences with a single-nucleotide variation in KRAS oncogene. The superparamagnetic particle-enhanced SPR assay detected p.G13D mutated DNA in buffer and spiked plasma at sub-attomolar level (0.5 aM, < 300 copies mL^{-1}) with minimal sample manipulation. Microfluidic channels connected to the active surface optimized the sample volume to 20 µL and the workflow time to less than 2 hours per single analysis. Additionally, the assay was validated using human plasma through liquid biopsy, successfully distinguishing four-point mutated DNA from colorectal cancer patients from wild-type DNA from healthy donors.

Conclusions: Based on superparamagnetic particles, the new SPRI biosensing strategy offers a straightforward and amplification-free detection of tumour-derived genetic materials circulating in human plasma as a valuable tool for cancer diagnosis and monitoring.



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Topics

Optical transducers

Bellassai, Noemi[1]; D'Agata, Roberta[1]; Giordani, Elena[2]; Zicchedu, Giovanna[2]; Corradini, Roberto[3]; Spoto, Giuseppe[1]

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ORAL COMMUNICATION

5th European Biosensor Symposium

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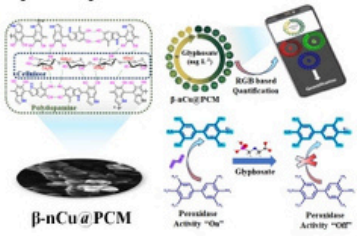
Abstract Title:

Nanozyme-Powered Cellulose Membrane for Smartphone-based Glyphosate Determination in Food

Abstract body:

Glyphosate (GLY), a ubiquitous organophosphorus herbicide, has emerged as a global environmental contaminant of concern due to its persistence and potential health hazards.[1,2] GLY is a nonselective, wide-ranging, and most utilized herbicide with an estimated yearly use of 600–750 thousand tons and an anticipated use of 740–920 thousand tons by 2025.



In response to the urgent demand for efficient monitoring strategies, we propose a bifunctional cellulose membrane integrating β-cyclodextrin-capped copper nanoflower (β-nCu) within a polydopamine-modified matrix (β-nCu@PCM), engineered as a nanozyme-based colorimetric sensor and passive filtration system for GLY detection and removal. The GLY 'poisons' the nanozyme activity, primarily through host–guest interactions with the β-cyclodextrins, which act as a chemical pocket for GLY housing via hydrogen bonding; this non-covalent GLY's 'encapsulation' inhibits the nanozymatic reaction, suppressing the colorimetric response. The system offers a broad linear detection range (5–100 mg·L^{-1}) and a low detection limit (0.4 mg·L^{-1}), enabling the rapid and selective GLY determination in food (i.e., seeds, cereals, and beans) at the respective maximum residual level admitted by the law (recoveries 95-106 %; RSD ≤4%, n=3) using a simple smartphone. Beyond sensing, the membrane demonstrates high GLY removal efficiency (81%), validated through static adsorption and dead-end filtration experiments. The membrane also maintained stable water flux under varied environmental conditions, making it a potential candidate for practical deployment.

This work presents a low-cost portable solution for integrated monitoring of GLY contamination, where the combination of nanozyme catalysis and membrane filtration provides a promising platform for on-site environmental pesticide surveillance, especially in resource-limited settings.

Acknowledgements:

This study received funding from the European Union—Next-Generation EU—National Recovery and Resilience Plan (NRRP) – MISSION 4 COMPONENT 2, INVESTIMENT N. 1.1, CALL PRIN 2022 PNRR D.D. 1409 14-09-2022 – (Project No. P2022T3HFA_02; HYDEAL4safety) CUP C53D23007760001

Keywords: Nanozyme, Colorimetric sensor, Nanostructured cellulose substrate, Glyphosate, paper-based device

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Topics

Optical transducers

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Abstract Title:

Newly designed molecular beacon for SERS-based miRNA detection

Abstract body:

Among emerging biomarkers, microRNAs (miRNAs) are attracting increasing interest due to their involvement in the regulation of gene expression and their impact on the onset and progression of numerous human diseases. In this work, we present a signal-off detection strategy for miRNA based on a molecular beacon (MB) labelled with a Raman reporter and immobilized on a surface-enhanced Raman scattering (SERS) substrate. The MB acts as the biorecognition element: upon hybridization with the target miRNA, the spatial configuration changes, altering the distance between the Raman tag and the plasmonic surface, and leading to a significant decrease in the SERS signal.

The sensor targets miRNA-183, which is known to be highly expressed in chronic obstructive pulmonary disease (COPD), a complex and heterogeneous inflammatory condition with variable therapeutic responses. Following preliminary fluorescence characterization, the Raman-labelled MB was employed for SERS-based detection using a multi-well device optimized for reproducible measurements.

To enhance sensitivity while maintaining a cost-effective and user-friendly format, we developed a plasmonic substrate composed of a dense network of silver nanowires (AgNWs), engineered to increase molecular density near SERS hotspots. This design enabled highly efficient signal transduction and contributed to achieving sub-femtomolar detection limits for miRNA-183 after surface optimization.

The assay demonstrated good specificity and allowed for multiple regeneration and reuse cycles, supporting its potential for practical biomedical applications in miRNA profiling and disease monitoring.

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Acknowledgments This work was supported by the European Union - Next Generation EU, project ECS00000017 ‘Ecosistema dell’Innovazione’ Tuscany Health Ecosystem (Spoke 4: Nanotechnologies for diagnosis and therapy).

Topics

02 Optical transducers -

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Abstract Title:

NP-NP FRET with Fluorescent Organic Nanoparticles for Biosensing applications

Abstract body:

Developing highly sensitive and robust optical biosensors requires luminescent transducers with high brightness and strong photoresistance to lower the limit of detection and increase the observation time. Luminescent nanoparticles (NPs) such as quantum dots, upconversion and fluorescent organic NPs outperform traditional molecular organic dyes by offering superior brightness and photostability[1]. In addition, their functionalizable surface constitutes a versatile platform to design multivalent biosensors.

A key mechanism for nanoscale sensing is Förster Resonance Energy Transfer (FRET)[2], a non-radiative energy transfer that arises from the interaction of the transition dipoles of a donor fluorescent species (D) and an acceptor (A) that absorbs energy. FRET efficiency depends strongly on the donor-acceptor distance (r), which typically ranges from 1 to 10 nm and decreases in $1/r^6$. When FRET is combined with bioreceptors, it allows to build biosensors where the fluorescence spectra evolves with the analyte concentration[3]. When NPs are used as tranducers instead of small molecules, their superior brightness permit to decrease the sensor's limit of detection[4]. While FRET between molecular dyes or FRET with NPs as donors and molecular species as acceptors has been largely studied[1], only a few examples of FRET between NPs (NP-NP FRET) can be found in the literature, and are mostly described with quantum dots.

This work investigates NP-NP FRET using metal-free fluorescent organic NPs to develop ultra-sensitive nanosensors. The studied NPs possess a core-shell structure consisting of a hydrophilic functionalizable shell (carboxylic acids groups) and a hydrophobic fluorescent core (dye copolymerized with styrene), containing up to thousands of chromophores per NP for a high brightness[5]. By fine-tuning their optical properties and functionalizing their surfaces with biomolecules, we aim to create efficient NP donor-acceptor FRET pairs for the development of a highly sensitive drug biosensor.

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This project has received funding from the European Research Council (ERC) under European Union's Horizon Europe research and innovation program (Grant agreement number 101077364).

Topics

Optical transducers

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Abstract Title:

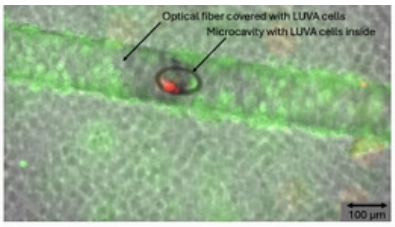
Optical fiber microcavity Mach-Zehnder interferometer for monitoring semi-adherent cell culture

Abstract body:

Research on human cells forms the cornerstone of modern biomedical sciences, providing critical insights into fundamental physiological and pathological processes. Culture monitoring, ideally performed in real time, is crucial when investigating the impact of disturbing physical or chemical factors. When cells are adherent, their monitoring is possible with electrical measurements; however, these may not be suitable for suspension cells.

In this work, we introduce a microcavity Mach-Zehnder interferometer (μIMZI) fabricated in a single-mode optical fiber as an innovative tool for diverse cell culture monitoring. It has an advanced ability for direct, label-free, and real-time observation of cell morphological changes, adhesion, division, and proliferation [1]. The μIMZI, using the principle of interferometry, provides high sensitivity to changes in optical properties both at the microcavity bottom and within its volume at a certain distance from the microcavity bottom [2]. This method provides deeper optical penetration than traditional techniques, such as surface plasmon resonance, thereby enhancing the efficiency of monitoring changes in several-micrometer-thick cells and suspended cells. In this experiment, we used an immortalized human mast cell line (LUVA) serving as a valuable model due to its "hybrid" growth characteristics [3]. These cells can be maintained primarily in suspension but also exhibit a capacity for adherence depending on the environment. This versatility allowed us to demonstrate the sensor's capabilities across varying cell states. Sensor readouts were correlated with bright-field microscopy imaging during experiments and further validated with fluorescent microscopy.

The results indicate that the sensor may be a promising solution not only for adherent, but also for suspension cell culture monitoring and deliver enhanced information about cell culture state, especially when microscopic analysis is unavailable or impossible to perform. This solution offers unique possibilities for the precise analysis of dynamic biological processes and suggests its broad utility across various cell lines.



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Topics

Optical transducers

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Abstract Title:

Plasmonic biosensor and binding inhibition assay for detection of tramadol

Abstract body:

Detection of small pharmaceuticals in environmental samples is challenging for optical affinity biosensor technologies, primarily due to the minimal mass changes these molecules produce upon binding. Direct detection typically lacks sufficient sensitivity, necessitating the use of indirect detection methods such as binding inhibition assays. Surface plasmon resonance (SPR) biosensors have been extensively explored for detecting small analytes. However, achieving optimal biosensor performance through binding inhibition assays requires meticulous optimization of biosensor design and assay conditions. The lack of quantitative theoretical models complicates this optimization, often resulting in a labor-intensive and costly empirical approach.

We investigated the relationship between receptor concentration in binding inhibition assays and the half-maximal inhibitory concentration (IC50), combining theoretical modeling with experimental investigation using the SPR biosensor technology. The optimized binding inhibition assay was applied for detecting tramadol, a low-molecular-weight pharmaceutical, in river water samples.

Our analysis demonstrated that IC50 decreases with decreasing receptor concentration in the sample, asymptotically approaching the equilibrium dissociation constant of the receptor–analyte interaction; a similar trend was observed for the limit of detection (LOD). Utilizing the optimized receptor concentration, the SPR biosensor detected tramadol in water samples over a dynamic range spanning five orders of magnitude, achieving an LOD of 520 ng/L. Application in a small-scale environmental study analyzing river water samples yielded results consistent with HPLC-MS/MS analysis, confirming the accuracy and reliability of the biosensor-based approach [1].

In conclusion, we established an analytical model to estimate optimal receptor concentrations for maximizing biosensor performance and used an SPR biosensor with binding inhibition assays to detect low levels of

tramadol in environmental samples. This approach offers a foundation for optimizing assay conditions and improving sensitivity in both biosensor and conventional methods, such as ELISA and RIA.

Abstract References

[1] M. Capková, E. Hemmerová, J. Homola: Surface plasmon resonance biosensor for environmental detection of tramadol, Analytical and Bioanalytical Chemistry 417, 2859-2865 (2025).

Topics

Optical transducers

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OTHER DEVICES

POSTER

5th European Biosensor Symposium

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Abstract Title:

A field-effect biological transistor for real-time, quantitative, specific and label-free biosensing

Abstract body:

Transistor-based biosensing is the holy grail of medical diagnostics as it supports low-cost self-use and point-of-care tests in a multiplexed manner from ultra-small physiological samples. Still, transistor-based specific and label-free sensing technology is not available today despite continuous efforts during the last several decades. We recently developed and introduced the Meta-Nano-Channel (MNC) field-effect biosensor for specific and label-free sensing of diverse molecular interactions. The MNC biosensor addresses solid-solution interface challenges related to the demand for electrochemical equilibrium of solution and molecular species during measurements, and the localization challenge of molecular gating. The MNC chip is fabricated exclusively for us in a large-scale chip factory (Tower Semiconductor) providing stability, robustness, and excellent electronic grade inherent to the CMOS (complementary metal-oxide semiconductor) process. Moreover, the extreme miniaturization of CMOS technology provides the infrastructure for unparalleled multiplexed sensing from ultra-small samples, as well enabling embedded chip configurations comprising additional circuitry related to logic, switching, memory, antennas, etc. The MNC biosensor has been demonstrated for sensing in neutral solutions, diluted serum, diluted plasma, and milk samples with typical limit-of-detection (LOD) in the range of fg/mL, with about 10 orders of magnitude in dynamic range and with excellent sensitivity and linearity1–5. In the talk I will present the underlying methodology of the MNC biosensor. Also, I will present direct MNC biosensor measurements of several molecular interactions in 0.5 µL samples of blood and sweat samples. The measurements are performed without any sample preprocessing and without premeasurement washing steps for the removal of the non-specific species. The sensing is quantitative and performed in real-time. We believe the MNC biosensor method provides real opportunities for the utilization of FET devices towards diverse applications concerning molecular sensing.

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Topics

Other devices

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FLASH PRESENTATION

5th European Biosensor Symposium

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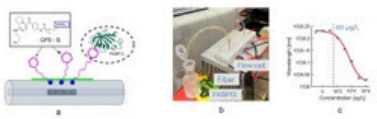
Abstract Title:

A novel FKBP12 sensor using long period optical fibre gratings

Abstract body:

Optical fiber long period gratings (LPGs) are being increasingly proposed as optical platforms for label-free biosensing as promising alternatives to the most traditional ones based on surface plasmon resonance or on interferometric configurations. LPGs have been demonstrated to offer comparable performance with respect to more classical optical platforms, but with the intrinsic advantages of the optical fibers, such as high compactness and potential miniaturization, as well as high compatibility with optoelectronic devices [1]. An LPG-based fiber optic sensor has been developed for the protein FBKP12, a protein that has been found to be involved in several tumor pathologies, including lung cancer. The biological recognition element is a novel molecule characterised by a chemical structure mimicking the natural FKBP12 binders such as Tacrolimus and Rapamycin [2] which is immobilised - via a self-assembled monolayer - on the fibre surface in correspondence of the fabricated LPG (Fig.1a). The resulting optical fibre is placed in a PMMA microfluidic flow cell, equipped with a Peltier cell for thermal stabilization (Fig.1b). The measurement is performed adding increasing concentration of FKBP12, with each addition separated by washing steps. More specifically the protein FKBP12 is injected in the flow-cell at increasing concentrations in the range 1 pM - 0.1 µM (in PBS) and incubated for 15 minutes with a 3-minute washing step after each incubation. The LPG transmission spectra are acquired after each washing step in stop-flow condition by means of an optical spectrum analyser and the shift of the resonance wavelength as a function of the FKBP12 concentration is calculated by fitting the LPG transmission spectrum with a multi-order polynomial fit. The limit of detection of 60 µg/L is achieved (Fig.1c).

This work was supported by European Union - Next Generation EU, project ECS00000017 ‘Ecosistema dell’Innovazione’ Tuscany Health Ecosystem (Spoke 4: Nanotechnologies for diagnosis and therapy).



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Topics

09 Other devices -

Baldini, Francesco[1]; Bartolini, Cosimo[2]; Caminati, Gabriella[2]; Frigenti, Gabriele[1]; Ishaq, Ahstham[2]; Marcucci, Niccolò[1]; Menichetti, Stefano[2]; Tombelli, Sara[1]; Tozzetti, Martina[2]; Trono, Cosimo[1]

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Anchoring and differentiation of dopaminergic neurons on gold. Monitoring their activity by microarray immunosensing

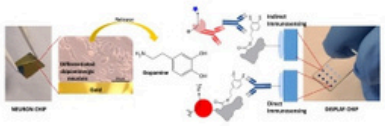
Abstract body:

Monitoring the behaviour of dopaminergic neurons helps fighting neurodegenerative disorders. The development of *in vitro* models reduce both the time and economic cost of experimental assays, allowing studying the disease mechanism and new therapeutic strategies. Our goal is anchoring dopaminergic neurons on Au electrodes and on-line monitoring the release of dopamine by means of a microarray immunosensor.

The neuron model consists of SH-SY5Y cells -a human neuroblastoma-derived cell line widely used as an *in vitro* model for dopaminergic neuronal function and differentiation- anchored onto SiO2 substrate coated with Au. Immobilization uses thiol-Au covalent bonding chemistry, building a *self-assembled monolayer*. The optimal protocol for cell differentiation into a dopaminergic phenotype consists of reducing serum levels in the culture medium and using all-trans retinoic acid and phorbol 12-myristate 13-acetate [1]. Cell differentiation is monitored via *Western blot* and reverse transcription of mRNA followed by RT-PCR. In addition, dopamine production can be assayed by ELISA. The results show that cells are attached and differentiated on gold, but also unspecifically on SiO2 surface in a lower extent. Also, dopamine production of attached cells is clearly higher after differentiation.

In parallel, the dopamine immunoassay model is developed onto glass. First, dopamine is attached to proteins BSA, OVA and lactoglobulin, following a carbodiimide-based protocol. Conjugates are also bound to Au nanoparticles by adsorption. Three different anti-dopamine antibodies are tested, in two competitive heterogeneous immunoassay modes: i) *direct* immobilized antibody and ii) *indirect* immobilized conjugate. Furthermore, three anchoring methods are assayed: i) passive adsorption, ii) thiol-ene covalent bonding, and iii) ethoxyaminopropylsilane/carbonyldiimidazole anchoring [2]. The best combination in all cases are

dopamine-OVA conjugate, a polyclonal antibody raised with dopamine-OVA immunogen, and propylsilane anchoring. The limits of detection achieved are at the sub-µg/L level, well below the dopamine concentration released by dopaminergic neurons in culture media.



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Topics

Other devices

Seco-Baquero, Julia[1]; Elizondo-Goñi, Iñigo[1]; Cardona-Serrate, Fernando[2]; Laguna-Heras, Maria Fe[3]; Holgado, Miguel[3]; González-Martínez, Miguel Ángel[4]

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Automated Patch Clamp for the Detection of Tetrodotoxin and the Toxicological Characterisation of its Analogues

Abstract body:

Tetrodotoxins (TTXs) rank among the most potent neurotoxins found in marine environments, with pufferfish serving as their primary vector. These toxins act by blocking voltage-gated sodium channels (VGSCs) in excitable cells, leading to severe gastrointestinal and neurological effects that can be fatal. Over 30 structural analogues of TTX have been identified to date, although their specific toxicological contributions remain largely unclear. In this study, we present an automated patch clamp system as a high-throughput, cell-based biosensing platform for detecting TTX and its analogues in pufferfish tissue. By monitoring electrophysiological changes in Neuro-2a cells exposed to tissue extracts, the system exhibited a half maximal inhibitory concentration (IC_{50}) of 6.4 nM for TTX. The assay's performance remained unaffected by matrix effects from TTX-free pufferfish tissue, even at concentrations up to 10 mg/mL. Consequently, a limit of detection (LOD) of 0.05 mg TTX equivalents/ kg was achieved, well below Japan's regulatory threshold of 2 mg/kg. The platform was also used to derive toxicity equivalency factors (TEFs) for five TTX analogues isolated from the liver of a *Lagocephalus sceleratus* specimen. The platform was further employed to derive toxicity equivalency factors (TEFs) for five TTX analogues isolated from the liver of a Lagocephalus sceleratus specimen. Subsequently, naturally contaminated pufferfish samples were analysed using the automated patch clamp and the results compared with LC-MS/MS quantifications, following TEF application. Excellent correlations were observed, thereby confirming the reliability of the system. In summary, automated patch clamp technology offers a rapid, highly sensitive, and robust method for the toxicological screening of TTXs in seafood, contributing to improved food safety and public health protection.

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Topics

Other devices

Reverté, Jaume[1]; Sureda, Francesc X.[2]; Tudó, Àngels[2]; Alkassar, Mounira[1]; Rambla-Alegre, Maria[1]; Sanchez-Henao, Andres[3]; Mandalakis, Manolis[4]; Peristeraki, Panagiota[5]; Diogène, Jorge[1]; Campàs, Mònica[1]

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Integrated paper/transition metal dichalcogenides colorimetric device for the nanozymatic-sensing of glutathione in saliva

Abstract body:

Herein, a colorimetric paper-based device (PAD) for the direct glutathione (GSH) determination in saliva is proposed. The device sensing ability is based on the GSH-induced inhibition of the peroxidase (POD)-like activity of paper-integrated transition metal dichalcogenides 2D-nanoflakes (TMDs).

TMDs (i.e., MoS_2, WS_2, $MoSe_2$, and WSe_2) were nanostructured via sonochemical exfoliation in water using sodium cholate as stabilizing agent, and for the first time, their POD-like activity was comprehensively studied on paper towards TMB (3,3',5,5'-tetramethylbenzidine) oxidation. The nanozymatic activity of the four TMDs was carefully tested on six different papers under varying TMD loading conditions. MoS_2 resulted in the most performing 2D-TMD in combination with the Whatman 602H paper. The MoS_2-PAD was thus used to build up a smartphone-based colorimetric strategy that relies on the GSH-mediated inhibition of catalytic TMB oxidation, resulting in a blue color switch-off.

The MoS_2-PAD (**Figure 1**) was conceived to host a 3-point 'control calibration' and sample analysis in triplicate. Its manufacturing relies on the printing of hydrophobic barriers on paper to define the sensing spots, acting also as MoS_2 and TMB reservoirs; this was performed using a simple portable wax printer. The MoS_2-PAD smartphone-based colorimetric assay consists of two straightforward steps: (i) saliva and H_2O_2 loading, (ii) smartphone readout after 10 min. The GSH matrix matched calibration returned a linear range enclosed between 0.5 and 10 µM (R^2=0.991) with a LOD of 0.14 µM, showing a useful inter-batch reproducibility (RSD≤4%, n=3). The device reliability was demonstrated through GSH determination in 17 real saliva samples, obtaining accurate (recovery: 81-117%) and reproducible data (RSD≤16%, n=3), correlated with the Ellman-reference method (r=0.972).

Summing up, the proposed PAD enables GSH determination at physiological relevant levels, requiring only 3 µL of sample, representing a step beyond toward point-of-care device based on nanozymatic matter.

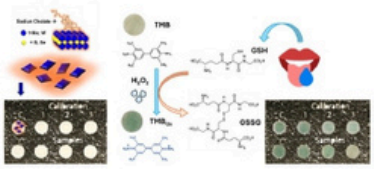

Figure 1. Sketch of the GSH sensing.

Abstract References

Acknowledgments This work has been funded by the European Union - NextGenerationEU, Mission 4, Compo-nent 1, under the Italian Ministry of University and Research (MUR) National Innovation Eco-system grant ECS00000041-VITALITY -CUP: C43C22000380007

Topics

Other devices

Scroccarello, Annalisa; Di Battista, Paolo; Della Pelle, Flavio; El Fadil, Dounia; Compagnone, Dario
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POSTER

5th European Biosensor Symposium

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Abstract Title:

Low cost printable and flexible nano-material based sensor devices for biochemical sensing applications

Abstract body:

The demand for real-time, cost-effective, and portable biochemical sensing solutions has catalyzed the development of flexible, nanomaterial-based sensor devices. In this presentation we focus on the fabrication of low-cost, printable, and flexible sensors utilizing advanced nanomaterials such as MXenes, graphene, and metal oxide nanostructures. These materials are integrated onto flexible substrates through scalable printing techniques, enabling the production of sensors that are both economically viable and adaptable to various applications.

The sensors are designed to detect a range of biochemical analytes, including nucleic acids, glucose, and other biomarkers, with high sensitivity and specificity. By employing printed electrodes modified with functional nanomaterials, the devices achieve enhanced electrochemical performance, facilitating rapid and accurate detection in complex biological samples. The integration of these sensors with electrochemical detection systems and computer aided devices allows for real-time monitoring, making them suitable for point-of-care diagnostics and environmental assessments.

This work aligns with the growing trend of utilizing nanomaterial-based sensors for various applications, as highlighted in recent studies on non-enzymatic glucose sensors and flexible pressure sensors. The approach presents a significant advancement in the field of biochemical sensing, offering a practical solution that combines affordability, flexibility, and environmental responsibility.

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Tahmineh Mahmoudi, and Yoon-Bong Hahn. High performance chemical sensor with field-effect transistors array for selective detection of multiple ions. Chemical Engineering Journal 417 (2021) 128064. 3. Kiesar Sideeq Bhat, Umesh T. Nakate, Jin-Young Yoo, Yousheng Wang, Tahmineh Mahmoudi, and Yoon-Bong Hahn* Cost-effective Silver Ink for Printable and Flexible Electronics with Robust Mechanical Performance. Chemical Engineering Journal, 373 (2019) 355-364. 4. Kiesar Sideeq Bhat, Umesh Tukaram Nakate, Jin-Young Yoo, Yousheng Wang, Tahmineh Mahmoudi, and Yoon- Bong Hahn* Nozzle-jet printed Ag/rGO based flexible FET sensor for phosphate ion detection. ACS Omega, 2019, 4 (5), pp 8373-8380. 5. Kiesar Sideeq Bhat, Rafiq Ahmad,* Jin-Young Yoo, Yoon-Bong Hahn* Fully nozzle-jet printed non-enzymatic electrode for biosensing application. Journal of Colloid and Interface Science 512 (2018) 480-488. 6. Kiesar Sideeq Bhat, Rafiq Ahmad, Jin-Young Yoo and Yoon-Bong Hahn* Nozzle-jet printed flexible field-effect transistor biosensor for high performance glucose detection. Journal of Colloid and Interface Science 506 (2017) 188-196. 7. Kiesar Sideeq Bhat, Rafiq Ahmad, Yousheng Wang and Yoon-Bong Hahn* Low-temperature sintering of highly conductive silver ink for flexible electronics. J. Mater. Chem. C, 2016,4, 8522-8527. 8. Kiesar Sideeq Bhat, Hyejin Kim, Asrar alam, Myunggon Ko, Jungeun An, Sooman Lim. A fast and label-free detection of hydroxymethylated DNA using a nozzle-jet printed AuNPs@Ti3C2 MXene-based electrochemical sensor. Talanta, 244, 123421.

Topics

Other devices

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FLASH PRESENTATION

5th European Biosensor Symposium

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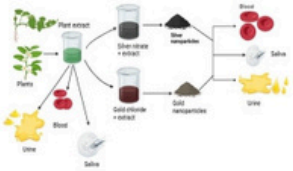
Abstract Title:

Moringa oleifera and Marula-derived platforms for the detection of body fluids at the crime scene

Abstract body:

A key aspect of forensic investigation involves identifying and detecting body fluid stains, preserving them for subsequent DNA extraction, and identifying the right criminals. The body fluid stains frequently encountered at a crime scene are blood, urine, and saliva. The process of stain identification might provide challenges due to the limitations of current techniques, which are primarily focused on certain body fluids and often involve destructive procedures. Chemical reagents such as luminol and DMAC mostly detect blood and urine at crime scenes, however, these chemicals have limitations like short shelf life, lower specificity, and sensitivity. To address these concerns, alternate materials derived from extracts of *Sclerocarya birrea* and *Moringa oleifera* stems were used in this project to provide a universal, confirmatory, and non-invasive methodology capable of identifying and distinguishing various bodily fluids. Silver and gold nanoparticles from these plants were used to enhance the performance of Luminol and DMAC to be more sensitive and specific to a specific fluid stain.



AgNPs and AuNPs were synthesized through a green chemistry method. The maceration method was used to extract the polar compound to reduce silver nitrate to silver nanoparticles and gold chloride to gold nanoparticles. Promising results were discovered from this project, strong and long-lasting chemiluminescence of Luminol was observed after the addition of nanoparticles. Extracts of *Sclerocarya birrea* and *Moringa oleifera* were used alone as alternative materials to luminol and DMAC and indicated results that are similar to colorimetric techniques. The study of DNA integrity by electrophoresis gel and Nanodrop was conducted, and it was discovered that DNA was preserved when plant extracts, AgNPs, and AuNPs were used in the detection of body fluids. The properties of AgNPs and AuNPs were verified

through characterization techniques including TEM, HRSEM, FTIR, XRD, UV-Vis fluorescence spectroscopy, and zeta potential analysis.

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Topics

Other devices

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5th European Biosensor Symposium

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Abstract Title:

Nature-inspired encapsulation strategies for implantable and bioresorbable temperature sensors for biomedical applications

Abstract body:

Introduction

Bioresorbable sensors are of increasing interest in biomedical diagnostics, particularly for temporary patient monitoring during critical postsurgical phases. In addition to the detection of inflammatory markers in the wound, temperature monitoring is a key physiological parameter [1]. Magnesium (Mg) as resistance and polylactic acid (PLA) as substrate material, both biocompatible and bioresorbable [2, 3], can be combined as future implantable resistance temperature detectors (RTDs) for temperature monitoring. Here, one remaining challenge is dedicated to enhance the RTD's lifetime under physiological-type conditions.

Materials and Methods

Meander-shaped magnesium-based RTDs were fabricated on PLA substrates via physical vapor deposition and encapsulated with either beeswax (BW) or carnauba wax (CW). Resistance measurements were carried out in a temperature regime between 30 °C and 43 °C under two environmental conditions: ambient air and tissue-like conditions in hydrogel.

Results and Discussion

Figure 1 displays representative resistance-time profiles of BW- and CW-encapsulated Mg-based RTDs under ambient air conditions. Both encapsulations allowed clear detection of temperature steps between 30 °C and 43 °C in 0.3 °C increments. Resistance measurements under tissue-like conditions in hydrogel showed that only the CW-encapsulated RTDs can reach an operational lifetime of about 72 hours, which is necessary for postoperative monitoring. At the same time, visible signal drift effects due to corrosion can be observed. Instead, BW-encapsulated RTDs fail above 35 °C under tissue-like conditions, likely due to their lower melting point and water permeability.

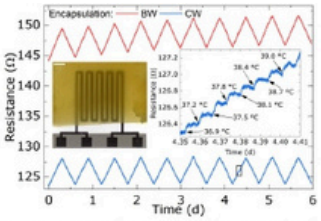

Figure 1: Exemplary Mg-based RTDs with the "natural" encapsulation materials beeswax (BW) and carnauba wax (CW) on a bioresorbable PLA substrate between 30 °C and 43 °C in 0.3 °C steps under ambient air conditions. The inlet shows the magnification of a section of the 8th heating cycle of the CW-encapsulated RTD. The picture (left) presents an exemplary CW-encapsulated Mg-based RTD. The white bar corresponds to 2 mm.

Conclusion

Both natural waxes enabled measurements under ambient air conditions having a temperature coefficient of about 0.003 °C^{-1}. Under tissue-like conditions, CW proved sufficient robustness for a 72-hour measurement period.

This study demonstrates the potential of natural waxes as encapsulation of implantable, bioresorbable RTDs, highlighting their value for sustainable, temporary biomedical devices.

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Topics

09 Other devices -

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5th European Biosensor Symposium

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Abstract Title:

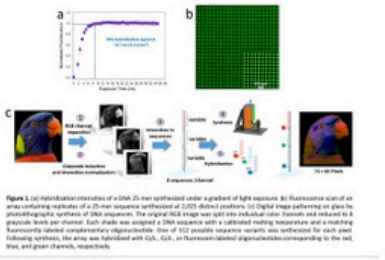
Scalable Photolithographic Nucleic Acid Synthesis Platform for Multiplexed Biosensor Applications

Abstract body:

The fabrication of multiplexed nucleic acid biosensors requires high-throughput methods that enable selective immobilization of biorecognition elements at defined positions across large areas. This is especially relevant for electrical and electrochemical label-free devices, where precise immobilization prevents cross-contamination and non-specific signals. Microarray photolithography offers a promising strategy to meet this need by enabling the synthesis of thousands of unique nucleic acid sequences in parallel and *in situ*, with high spatial precision1,2. This technique adapts conventional phosphoramidite chemistry by installing photosensitive protecting groups at the 5'-hydroxyl position. Synthesis occurs directly on functionalized surfaces via repeated cycles of coupling, oxidation, and UV light-mediated photodeprotection3,4. However, to enable scalable biosensor production, often involving larger and more complex formats than standard microarrays, this approach requires integration of an optical system capable of rapidly illuminating extended surface areas.

We present a prototype laser scanning system for photolithographic synthesis of nucleic acids. It features a 405 nm 180 mW laser, a 2-axis scanning mirror, and programmable control of laser power and exposure time. Varying synthesis areas, of up to 110 mm × 110 mm, can be scanned using two different lenses, and with a zoom function that can adjust the laser spot size between ~100 and 700 µm. The system was tested by synthesizing DNA sequences on silane-functionalized glass slides using thiophenyl-NPPOC (SPh-NPPOC) phosphoramidites5, whose spectral absorption extends into the visible range, enabling photolysis at 405 nm. We demonstrated that complete SPh-NPPOC photolysis occurs within milliseconds using high-power lasers (Figure1a), allowing for the synthesis of thousands of replicates within minutes of illumination time per cycle (Figure1b). The device also shows high patterning capability, allowing for the reproduction of digital images by synthesizing DNA sequences and hybridizing with fluorescently labeled complements (Figure1c). These

results highlight the compatibility of this scalable laser-based approach with large-scale nucleic acid synthesis.



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Topics

Other devices

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Abstract Title:

Colorimetric Detection of MicroRNA Biomarkers Using Cysteamine-Stabilized Gold Nanozymes on Microbeads

Abstract body:

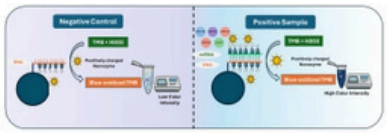
Background: MicroRNAs (miRNAs) are emerging biomarkers for early cancer and neurodegenerative disease diagnosis, yet their low abundance and high sequence similarity challenge conventional assays. A rapid, enzyme-free, multiplex-capable colorimetric method that is low-cost and suitable for point-of-care use in resource-limited settings remains unmet.

Materials & Methods: Cysteamine-stabilized gold nanoparticles (Cys/AuNPs) were electrostatically assembled onto streptavidin-coated microbeads bearing biotin-DNA probes. Upon miRNA hybridization, Cys/AuNP nanozyme activity catalyzed TMB oxidation in H_2O_2, and the blue product was quantified by UV–Vis spectrophotometry.

Results: The assay detected five synthetic miRNAs (miR-146a, miR-29a, miR-124a, miR-34a, Let-7b) with a linear response from 0 to 200 nM. Streptavidin-microbeads enabled efficient probe immobilization and target capture. The Cys/AuNPs exhibited high nanozyme activity, producing a robust, concentration-dependent blue signal without enzymatic labeling or amplification. Specificity was confirmed by negligible responses from non-complementary sequences.

Conclusions: This label-free, enzyme-free colorimetric platform simplifies multiplex miRNA detection, offering rapid, cost-effective analysis without amplification. Its robust sensitivity and specificity, combined with ease of use, make it a promising point-of-care diagnostic tool for resource-limited settings.

Graphical Abstract



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Topics

Other transducers

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Abstract Title:

Biosensors and their application in the characterization of water quality in urban sewage systems.

Abstract body:

In the field of urban drainage, there has been a strong growth in the application of new technologies in the last five years to monitor the structural condition of the sewer system, as well as to control water quality, characterized by variables such as level, velocity, and flow, as well as chemical composition; temperature, conductivity, turbidity, redox, or ORP.

This need for water quality monitoring responds to increasing public awareness of environmental issues and improving quality of life, the implementation of mandatory national and international regulations, the availability of European funding for the implementation of these regulations and the work generated from their results, as well as the cost and accessibility of new technologies typically entailed by the use of electronic sensors, for example.

Traditionally, the type of electronic sensors in this field that has been used are, on the one hand, ultrasound, electromagnetic waves, radar, magnetic field, or doppler, and, on the other, resistive, optical, or capacitive ones. In recent years, biosensors have begun to be used directly. These sensors allow a water quality monitoring based on the creation and variation of microbial cultures. These technologies achieve better results to those of traditional technologies, but at a lower long-term cost in terms of innovation, maintenance and operation.

The following paper aims to compare traditional methods of electronic sensors versus biosensors in the study of wastewater quality, highlighting technological improvements, method innovation, the establishment of new measurements and ranges, opportunities for medium- and long-term economic efficiency, and access to the information generated. Finally, a case study of the application of biosensors for the characterization of the chemical quality of wastewater in the Besos and Tordera rivers is proposed, as part of the PAITIDA project and funded by PERTE.

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Basic concepts in sensor network management for models. Lucas Stel, Juan Manuel Llavero and Alberto Soriano. SIMHYDRO 2025

Topics

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Abstract Title:

Detection of SARS-CoV-2 spike protein (ectodomain) by mini graphene field-effect transistors (mGFET-4D)

Abstract body:

Background:

COVID-19 has caused profound and widespread damage globally—socially, economically, and in terms of public health. As the virus continues to mutate, the development of a continuous and adaptable detection platform is vital to prevent future pandemic waves.

The ectodomain of spike protein of the SARS-CoV-2 virus directly interacts with the Angiotensin-Converting Enzyme 2(ACE2) receptor on human cells, facilitating viral attachment and entry. Studying this interaction can lead to the development of highly effective biosensors for the detection of both the virus and its variants.

In this context, graphene Field-Effect Transistors (GFETs) have emerged as powerful tools for biomarker biodetection, owing to their exceptional sensitivity, rapid response time, and capability for label-free detection. [1] In this work, we present a novel platform based on miniaturized Graphene Field-Effect Transistors (mGFET-4D), developed for the detection of the SARS-CoV-2 spike protein (ectodomain).

Materials & methods:

To achieve this, the mGFET-4D was functionalized with tetrakis(4-carboxyphenyl) porphyrin (TCPP), which was subsequently linked to the ACE2, through an EDC/NHS reaction, thereby creating a biosensor specific to the spike protein ectodomain. Each step of the mGFET-4D functionalization was characterized using Atomic Force Microscopy, Raman and X-ray Photoelectron spectroscopies (XPS) to confirm successful surface modification. Electric measurements were performed using a source meter, Keithley 2612B, a Graphenea Card and an external no-leak Ag/AgCl reference electrode.

Results:

A shift in the G band observed in the Raman spectra, along with an increase in the N1s signal in XPS, indicated successful ACE2 immobilization on the graphene surface. A significant shift of potential (22.5 mV) of the Dirac point was observed for the mGFET-4D biosensor after incubation with a solution of 1.88 fM Spike protein in PBS pH 7.4.

Conclusions:

The present work demonstrates the use of the ACE2 human receptor for detection of SARS-CoV-2 spike protein on the new mGFET-4D platform.

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Topics

Other transducers

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5th European Biosensor Symposium

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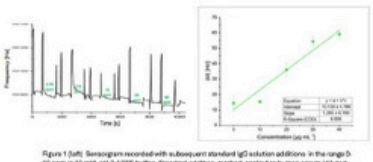
Abstract Title:

Development of a novel QCM-D instrumentation for affinity sensing by bioinspired Molecular Imprinted Polymers (MIP) for IgG detection in serum

Abstract body:

Background:

The use of QCM as a biosensor is possible by functionalizing the metal surface with an appropriate receptor that, in the presence of the analyte, will cause an increase in the mass on the metal surface and therefore a decrease in the oscillation frequency of the crystal recorded by the instrument[1]. The development of the



WinQCM apparatus, produced by Elbatech, a novel QCM-D instrumentation is reported together with an innovative biosensor application based on the green bioinspired Molecularly Imprinted Polymer (MIP)[2], derived from the neurotransmitter norepinephrine[3]. coupled to 10 MHz quartz crystals. The detection of IgG in human serum has been addressed.

Materials and Methods:

MIPs of Polynotephineprine (PNE) have been obtained by epitope imprinting by selecting the Peptide 439KSLSLSPGK447 (Fc CH3) on IgG1 as a template peptide. The MIP has adhesive properties, and it has been deposited on the gold electrode of the QCM by drop casting.

Results

WinQCM apparatus, coupled to PNE MIPs allows real time and label free detection of IgG in human serum (Figure 1). It has been possible also to estimate the kinetic parameter of the IgG and PNE-MIP film by Langmuir fitting from the Frequency grams.

From the fitting applied we calculated a serum IgG concentration of 7.90 mg mL-1. The value obtained, if compared with the nephelometric value, was determined with an accuracy of 94.2%.

Conclusion:

Molecular imprinting can be coupled to innovative bioispired receptors as PNE for the detection of clinical markers; This compact apparatus is challenging for application to other analytical targets.

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Topics

Other transducers

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Electrolyte-gated organic field-effect transistors for diagnostics

Abstract body:

Electrolyte-gated organic field-effect transistors (EGOFETs) are emerging as powerful, ultrasensitive, label-free biosensors due to their low cost, straightforward electrical readout, and inherent signal amplification. Their operation is based on the formation of two electrical double layers (EDLs) at the organic semiconductor–electrolyte and electrolyte–gate interfaces when a gate voltage is applied. This interaction modulates charge transport along the organic semiconductor, rendering EGOFETs highly responsive to interfacial changes—a property extensively harnessed in biosensor development.

A common approach for biosensor fabrication involves the biofunctionalization of the gate electrode using antibody or aptamer immobilization strategies, often mediated by Protein G or self-assembled monolayers (SAMs). Such methodologies have enabled the detection of biologically relevant molecules at ultra-low concentrations, positioning EGOFETs as promising candidates for next-generation point-of-care (PoC) diagnostics. In our group, we have leveraged this platform to detect alpha-synuclein, a biomarker of Parkinson's disease, with a detection limit as low as 0.1 pM, and to monitor the aggregation kinetics of beta-amyloids [1–2].

Despite their diagnostic potential, the portability of EGOFET-based assays is often hindered by limited microfluidic integration and labor-intensive, multi-step protocols. To overcome these limitations, we present a simplified EGOFET integrated with lateral flow paper fluidics, enabling a reusable, compact, and cost-effective PoC test with rapid turnaround (~30 minutes). This platform was validated for the detection of Human Immunoglobulin G, demonstrating a broad linear range, high selectivity, reproducibility, and an impressive detection limit of 0.1 fM [3].

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Topics

Other transducers

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

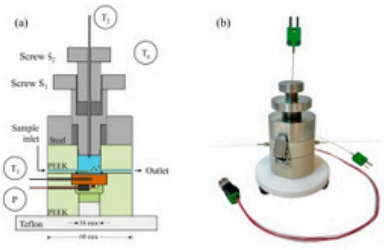
first_pagesettingsOrder Article Reprints Open AccessArticle Spontaneous Cell Detachment from Temperature Gradients: Getting the Method Ready for Antimicrobial Drug Testing at Cell Culture Level

Abstract body:

Spontaneous cell detachment is a thermally induced phenomenon where cells sediment onto a heated chip and detach collectively after a defined dwell time (td), influenced by temperature gradients. This behavior differs across yeast strains and cancer-cell lines and is sensitive to environmental factors such as nutrients and cytotoxins, making it a promising candidate for pharmacological screening. The underlying mechanisms, including the role of fluid convection, remain under investigation. This study explores the effect of convection and sample geometry on td to optimize the method for antimicrobial drug testing in cell cultures.

Experiments and fluid simulations were conducted using yeast cells in compartments with varying aspect ratios. The effects of chip temperature, gradient strength, and cell concentration on td were evaluated. Antimicrobial effects of an antibiotic and antiseptic were measured and compared with standard reference assays.

Dwell time (td) was found to be highly sensitive to the thermal environment and cellular conditions. Increased chip temperature and stronger vertical temperature gradients accelerated cell detachment, while higher cell densities extended td. Sample geometry influenced convective flows, thereby modifying td values. The addition of an antibiotic (tetracycline) and an antiseptic (benzalkonium chloride) led to measurable shifts in td, aligning well with inhibition trends observed in reference assays. These findings demonstrate the robustness and sensitivity of the spontaneous-detachment method for detecting antimicrobial effects at the cell culture level.



Spontaneous cell detachment, modulated by thermal and fluidic conditions, shows potential as a non-invasive, label-free technique for antimicrobial drug screening. Its ability to detect cytotoxic effects via td makes it a promising tool for early-stage pharmacological evaluations and biosensing applications.

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Bakhshi Sichani, S.; Khorshid, M.; Yongabi, D.; Urbán, C. T.; Schreurs, M.; Verstrepen, K. J.; Lettinga, M. P.; Schöning, M. J.; Lieberzeit, P.; Wagner, P. Design of a Multiparametric Biosensing Platform and Its Validation in a Study on Spontaneous Cell Detachment from Temperature Gradients. ACS Sens. 2024, 9 (8), 3967–3978. https://doi.org/10.1021/acssensors.4c00732 Yongabi, D.; Khorshid, M.; Losada-Pérez, P.; Bakhshi Sichani, S.; Jooken, S.; Stilman, W.; Theßeling, F.; Martens, T.; Van Thillo, T.; Verstrepen, K.; et al. Synchronized, Spontaneous, and Oscillatory Detachment of Eukaryotic Cells: A New Tool for Cell Characterization and Identification. Adv. Sci. 2022, 9 (21), 2200459. https://doi.org/10.1002/advs.202200459

Topics

Other transducers

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5th European Biosensor Symposium

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Abstract Title:

Haptoglobin Detection Via Hyaluronic Acid - Solid Lipid Nanoparticles Functionalized QCM Immunobiosensor: A Step Toward Non-Invasive Neurodiagnostics

Abstract body:

Neurodegenerative diseases (NDs), including Alzheimer's, Parkinson's, Huntington's disease, and Multiple Sclerosis, exhibit distinct molecular mechanisms but share common pathological hallmarks such as dopaminergic neuron degeneration, cognitive decline, and neuroinflammation[1]. These processes are closely linked to chronic inflammation and oxidative stress, which correlate with elevated levels of systemic biomarkers like haptoglobin (Hp), an acute-phase inflammatory glycoprotein. Studies indicate significantly higher serum Hp levels in ND patients compared to healthy controls, and its interaction with β-amyloid aggregates further underscores its potential as a biomarker for disease progression[2-5]. However, current diagnostic methods for Hp, such as ELISA and nephelometry, are costly, time-consuming, and lack sensitivity, while conventional ND biomarkers (e.g., tau, amyloid-β) require invasive cerebrospinal fluid (CSF) sampling[6-8]. To address these limitations, we developed the first quartz-crystal microbalance (QCM)-based immunobiosensor for rapid, non-invasive quantification of human Hp in human serum.

The immunosensor integrates an in-house QCM based device for dual high-resolution frequency/resistance measurements. Fabrication involved functionalizing the quartz surface with a thiolated polyethylene glycol amine (SH-PEG-NH_2) self-assembled monolayer, followed by immobilization of hyaluronic acid coated solid lipid nanoparticles (HA-SLNs). HA-SLNs, here used for the first time, were designed to enhance surface stability, antibody loading capacity, and sensitivity. Subsequent steps included covalent attachment of Hp antibodies and ethanolamine blocking to minimize nonspecific binding. The biosensor demonstrated robust analytical performance, achieving high sensitivity (612.10 ± 28.14 μg mL^{-1}), reproducibility (average coefficient of variation, CVav % = 0.50 %), selectivity, and exceptional limits of detection (0.06 ± 2.90 x 10^{-3} μg mL^{-1}) and quantification (0.21 ± 9.70 x 10^{-3} μg mL^{-1}). Layer-by-layer surface modifications were validated

using, time-of-flight secondary ion mass spectrometry (ToF-SIMS), atomic force microscopy (AFM), and electrochemical impedance spectroscopy (EIS).

This platform offers a cost-effective, user-friendly alternative for early ND diagnosis and monitoring by eliminating the need for CSF sampling.

Abstract References

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Topics

Other transducers

Lettieri, Mariagrazia[1]; Talarico, Luigi[1]; Gabbricci, Giulia[1]; Clemente, Ilaria[1]; Landi, Elia[2]; Fort, Ada[2]; Vignoli, Valerio[2]; Magnani, Agnese[1]; Consumi, Marco[1]

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ORAL COMMUNICATION

5th European Biosensor Symposium

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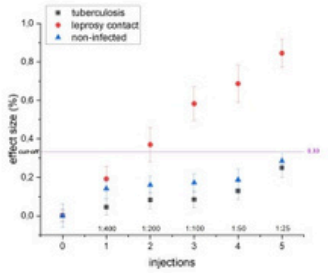
Abstract Title:

Heat Transfer-based immunobiosensor for serological detection of Mycobacterium leprae infection

Abstract body:

Background: Leprosy remains a significant global health issue, and the World Health Organization emphasizes the need for improved diagnostic tests to detect *Mycobacterium leprae* infection in both symptomatic and asymptomatic individuals(1). Currently, the diagnosis of leprosy relies primarily on symptoms and clinical manifestations(2). Moreover, the available diagnostic tools are insufficient for identifying individuals exposed to the bacterium who are at risk of developing the disease and transmitting it to others(3,4). Biosensors could represent an alternative to traditional diagnosis, offering the advantages of being low cost portability, and suitability for point-of-care testing. This study aimed to develop a proof-of-concept biosensor based on the Heat Transfer Method (HTM) and antigen–antibody interactions for use in non-invasive, specific, and sensitive serological screening of *M. leprae* exposure. **Materials and Methods:** Aluminium surface biofunctionalization was carried out using 20% Base Piranha solution(5), 3-aminopropyltriethoxysilane, and glutaraldehyde. Surface modification was confirmed through FTIR spectroscopy, EDX analysis, and an ELISA-like immunoassay. Thermal signal measurements were performed using the HTM. **Results:** The ELISA-like assay revealed clear differentiation between blank, non-infected, and infected sera. HTM analysis showed a temperature difference of 0.2 °C between contact and non-infected sera after five injections. This is relevant since contacts are at increased risk of developing leprosy and may contribute to transmission(4). Early detection with high sensitivity can support surveillance programs and prevent disease progression(1). The effect size was 2.5 times greater in infected sera compared to both non-infected and tuberculosis samples (Figure), indicating no cross-reactivity with other important *Mycobacterium* specie. **Conclusions:** To our knowledge, no biosensor with a similar architecture has been reported for leprosy detection. We successfully biofunctionalized aluminium surfaces for use in HTM-based biosensing devices and standardized the system using sera from individuals with distinct clinical statuses. This

represents an important step toward developing more sensitive immunosensor for early-stage leprosy



detection.

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Topics

Other transducers

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

Phase-Separating Peptides: A Convenient Tool for the Rapid Detection of Microbial Contamination in Highly Pigmented Produce

Abstract body:

Rapid detection of microbial contaminants in highly pigmented fruits and vegetables is often hindered by plant-derived pigments that interfere with conventional colorimetric and fluorimetric assays. We present a simple, two-step, solvent-free method using phase-separating peptides (PSPs) to detect *E. coli* and *Salmonella* in pigmented food matrices. PSPs, engineered with bacterial protease recognition sites, are added to aqueous food homogenates, where they spontaneously undergo liquid–liquid phase separation, forming coacervate droplets that efficiently sequester pigments. In the presence of Gram-negative bacteria, outer membrane proteases cleave the PSPs, preventing coacervation and leaving pigments suspended in the supernatant. A brief centrifugation step yields a clear supernatant in bacteria-free samples and a colored one in contaminated samples, enabling rapid visual and spectroscopic discrimination. To optimize performance, we designed a 63-member positional scanning peptide library with tunable hydrophobicity and sequence modifications. Systematic screening in aqueous buffer identified a subset of PSPs exhibiting strong coacervation and >95% pigment capture efficiency using Amaranth, a food dye. While bacterial viability and performance across different produce types remain to be validated, these aspects will be addressed in upcoming studies. The method is label-free, solvent-free, and compatible with standard colorimetric and fluorimetric platforms. It offers a fast, robust strategy for detecting bacterial contamination in pigmented foods and addresses a key limitation in food safety diagnostics by overcoming pigment-related assay interference.

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Topics

Other transducers

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5th European Biosensor Symposium

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Abstract Title:

Viscoelastic Properties of DNA Strands: A Quartz Crystal Microbalance with Dissipation Study on DNA Length Dependence

Abstract body:

This study focuses on the application of the Quartz Crystal Microbalance with Dissipation (QCM-D) module as a highly sensitive technique for investigating the viscoelastic properties of biomolecular layers. QCM-D simultaneously monitors mass changes and energy dissipation at the sensor surface, making it uniquely suited for characterizing soft, hydrated biological samples [1]. Here, we detail a comprehensive investigation into the viscoelastic properties of short polyAdenine (polyA) strands. Understanding the elastic behavior of nucleic acids is crucial for elucidating their roles in various biological processes, including DNA replication, transcription, and protein binding. We systematically examine thiolate polyA strands of varying lengths (5, 10, 15, and 20 bases) adsorbed onto a gold QCM-D sensor. By analyzing the shifts in frequency and dissipation upon adsorption, we quantify the shear elastic modulus and viscosity of the polyA layers. The influence of strand length on these intrinsic viscoelastic parameters is discussed, providing insights into the evolving flexibility and rigidity of these biomolecules as their length increases. Furthermore, we explore the hybridization of the polyA strands with polyThymine strands of corresponding lengths. This enables us to determine the elastic behavior of hybridization. This study aims to reveal how the length of polyA affects its mechanical characteristics and subsequently how does the hybridization change these characteristics. The findings contribute to a deeper understanding of the nanomechanical properties of nucleic acids and provide a robust methodology for their characterization.

Acknowledgements

This work was supported by the project "Plasmon mediated biology: Exploitation of plasmonics to investigate and enhance biological processes and application to biomedical issues (acronym: BioPlasmonics)" funded by European Union – NextgenerationEU and Romanian Government, under National Recovery and

Resilience Plan for Romania, contract no. 760037/23.05.2023, cod PNRR-C9-I8-CF-199/28.11.2022, through the Romanian Ministry of Research, Innovation and Digitalization, within Component 9, Investment I8.

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[1] D. Johannsmann and I. Reviakine, "Quartz crystal microbalance with dissipation monitoring for studying soft matter at interfaces," Nat Rev Methods Primers, vol. 4, no. 1, pp. 1–21, Sep. 2024, doi: 10.1038/s43586-024-00340-4.

Topics

Other transducers

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POINT-OF-CARE

POSTER

5th European Biosensor Symposium

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Abstract Title:

3D-Architectured Intelligent SERS Nano-profiler for Blood based Detection and Classification of Alzheimer's Disease

Abstract body:

Advancements in molecular diagnostics have spotlighted Surface-Enhanced Raman Spectroscopy (SERS) as a powerful modality for ultra-sensitive and minimally invasive disease detection. In this study, we present a three-dimensionally architectured SERS nanoplatform embedded with MXene nanosheets and plasmonic nanorods within the fibrous matrix of a nitrocellulose membrane. This innovative design harnesses synergistic electromagnetic and chemical enhancement mechanisms, yielding an exceptional analytical enhancement factor of 3.10×10^9 and an ultra-low detection limit of 69 fM for rhodamine 6G.1 The 3D fibrous network significantly amplifies hotspot density, offering enhanced signal intensity, sensitivity, and reproducibility.

Leveraging this platform, we developed a blood plasma-based diagnostic system for Alzheimer's disease (AD) detection and stage profiling. Raman spectral data acquired from patient plasma samples were analyzed using deep learning models to distinguish between mild cognitive impairment (MCI) and healthy controls. Distinct spectral variations, notably in carotenoid and aromatic amino acid profiles, correlated strongly with AD progression.2 A multi-layer perceptron classifier enabled stage-specific classification with over 80% accuracy and sensitivity.

This deep learning assisted SERS nanoplatform acts as both a high sensitive diagnostic tool and classification profiler, offering a promising leap toward intelligent, non-invasive, and rapid screening for AD and other neurodegenerative diseases.

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1. Sun T, Wu Y, Ma H, et al. The Design of WTe2/Graphene/Ag NPs Heterostructure for the Improvement of the Chemical Enhancement in SERS. Nano Lett. 2024;24(48):15324-15330. 2. Wang Z, Ye J, Zhang K, et al.

Rapid Biomarker Screening of Alzheimer's Disease by Interpretable Machine Learning and Graphene-Assisted Raman Spectroscopy. ACS Nano. 2022;16(4):6426-6436.

Topics

Point-of-care

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5th European Biosensor Symposium

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Abstract Title:

A flexible electrochemical aptasensor for ultrasensitive cortisol detection in biological fluids

Abstract body:

Background: Cortisol (COR) is an endogenous hormone involved in numerous physiological and pathological processes. Fluctuations in COR levels can be a result of certain inflammatory diseases such as long-COVID syndrome. Therefore, COR can successfully be used as a biomarker for the diagnosis and monitoring of this condition.

The aim of this study was to develop an electrochemical aptasensor for the non-invasive detection of COR from biological fluids such as saliva and sweat.

Materials and methods: Flexible electrodes were printed in-lab using conductive inks. The surface of the working electrode was functionalized with gold and platinum nanoparticles to increase sensitivity and act as anchoring sites for the COR-specific, ferrocene-labelled aptamer. The detection was carried out using cyclic voltammetry.

Results: Each functionalization step was confirmed using cyclic voltammetry and electrochemical impedance spectroscopy, as well as scanning electron microscopy and X-ray photoelectron spectroscopy. The aptasensor demonstrated a linear detection range from 0.5 to 100 nM, with an LOD of 0.1 nM. The sensor was applied for the detection of COR from raw saliva and sweat samples collected from long-COVID patients (n=10) and healthy controls (n=5). The results were compared with those obtained using an in-lab developed HPLC method and the ECLIA method, with no statistical differences between results.

Conclusion: An aptasensor for the non-invasive detection of COR was successfully developed and applied for the analysis of raw samples of saliva and sweat collected from long-COVID patients and healthy controls. No statistical differences were identified between the methods, indicating the suitability of the electrochemical aptasensor for COR monitoring.

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Irimes MB, Pusta A, Tertis M, et al. Specific Detection of Cortisol in Biological Fluids: A Tailored Electrochemical Aptasensing Approach. ACS Sensors. Published online July 1, 2025. doi:10.1021/acssensors.4c03105

Topics

07 Point-of-care -

Irimes, Maria-Bianca[1]; Pusta, Alexandra[1]; Tertis, Mihaela[1]; Tabirta, Andreea[1]; Achim, Eduard[1]; Suciu, Maria[2]; Leostean, Cristian[3]; Pana, Ovidiu[3]; Oprean, Radu[1]; Cristea, Cecilia[1]

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

A Flexible Electrochemical Platform for Alkaline Phosphatase Monitoring in Physiological Samples

Abstract body:

Alkaline phosphatase (ALP) plays a crucial role in numerous biological functions such as metabolism, regulation of gene expression, and molecular transport. Recognized as a promising biomarker in clinical diagnostics, ALP concentrations in serum offer important information regarding disease conditions and the effectiveness of treatments. In healthy adults, normal serum ALP levels generally fall between 40 and 190 U/L, whereas levels can surpass 500 U/L in children and pregnant women[1]. ALP is a critical biomarker in clinical diagnostics, with fluctuations in its serum levels linked to various pathological conditions including liver dysfunction, bone disease, and cancer metastasis. In this study, we report the development of a cost-effective and portable electrochemical biosensor for ALP detection, fabricated via screen-printing on flexible polyester substrates. The device employs disodium phenyl phosphate as a substrate, with phenol production quantified through differential pulse voltammetry. The sensor exhibited excellent analytical performance, achieving detection limits of 0.03 U/L in buffer and 0.08 U/L in diluted human serum, both well within the clinically relevant range. Optimization studies revealed that reliable measurements could be achieved without the need for incubation at physiological temperature, enhancing its suitability for point-of-care use. Notably, the sensor's operation requires no surface modification or complex nanomaterial integration, yet it retains sensitivity and reproducibility comparable to more intricate biosensing platforms. These findings support the potential of this minimalist, user-friendly electrochemical device as a powerful tool for decentralized ALP monitoring in biomedical and clinical settings. Its clinically significant LOD aligns with the lower end of the normal ALP range in human serum (20–40 U/L) and can detect ALP levels as low as 0.4 U/L (0.08 U/L in 20% serum samples), making it suitable for identifying ALP deficiency. These results validate the "less-is-more" concept, proving that complex designs and procedures are not always necessary for optimal performance [2].

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Topics

Point-of-care

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5th European Biosensor Symposium

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Abstract Title:

A Flexible MIP-integrated PVDF/BTO piezoelectric film for point of care detection of Para-Nitrophenol

Abstract body:

Background:

Flexible piezoelectric sensors hold huge promise for fabrication of wearable sensors enabling continuous monitoring of target analytes. However, the conventional piezoelectric films based on polyvinylidene fluoride/barium titanate (PVDF/BTO) often suffer from poor electron transport owing to low conductivity, which significantly hinders their practical implementation. To address this challenge, we incorporated molecularly imprinted polypyrrole (MIP)-a conductive polymer-into PVDF/BTO film to enhance the electron transfer rate and selectivity of the sensing platform.

Methods:

The approach involves three key steps: A facile sonochemical assisted calcination was employed to achieve tetragonality in BTO. For, MIP synthesis, the template to monomer ratio of 1:3.5 for oxidative polymerization was optimized by using Isothermal calorimetry resulting in a MIP with higher binding affinity towards para nitrophenol (p-NP), a key environmental pollutant. Finally, a flexible film integrated with polyvinylidene fluoride (PVDF) was fabricated by using classical solution casting method.

Results:

The fabricated film exhibited superior piezoelectric properties as confirmed by various spectroscopic and microscopic methods. Furthermore, the voltammetric studies revealed enhanced heterogenous electron transfer rates in the MIP-BTO/PVDF film, which was attributed to enhance electron delocalization and hopping, substantiated by electron spin resonance. Subsequent evaluation of sensing performance of MIP-BTO/PVDF through differential pulse voltammetric analysis revealed a wide linear range of 10-200 µM for p-

NP. The limits of detection were found to be 0.57 μM for p-NP, with a sensitivity of 4.68 μA μM^{-1} cm^{-2}. The MIP-BTO/PVDF film showed higher selectivity in tap water indicating its reliability for practical implementation.

Conclusion:

In a nutshell, fabricated platform effectively bridges the exiting gap between piezoelectric sensors and wearable sensors, enabling real time detection . Its biocompatibility alongside scalable fabrication method positions it as a viable choice for next generation portable electronics aimed at health and environmental monitoring.

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Presentation Preference

Oral Communication

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5th European Biosensor Symposium

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Abstract Title:

A Mobile LAMP based Magnetic Bioassay Approach for High Sensitivity Detection of Pathogens and Antibiotic Resistances

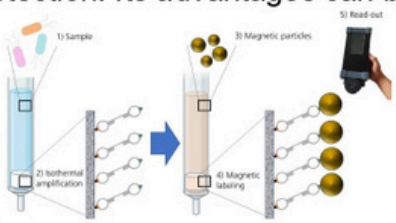
Abstract body:

Poultry farming faces significant challenges due to rapid spread of pathogens and emergence of antibiotic resistances, driven by the close proximity of animals. Current microbiological detection methods are not suited for rapid and precise responses as they require microbiological enrichment, qualified analytical labs or lack in sensitivity and specificity. This study introduces a novel mobile testing platform utilizing loop-mediated isothermal amplification (LAMP) coupled with magnetic immunodetection. It is designed to enable affordable point-of-care diagnostics with accurate detection of pathogens in under one hour, including the detection of emerging antibiotic resistances.

Since minimal pathogen levels can quickly impact animal health, our approach emphasizes high sensitivity to allow early treatment. We achieve this by combined magnetic enrichment and isothermal amplification of pathogen specific DNA. Amplification of pathogen-specific genetic regions employing LAMP is conducted inside a custom build measuring device. Hence, the analyte quantity for a sensitive detection increases. The resulting amplificates are enriched within a filter matrix and labelled by superparamagnetic particles. The *amplification-measuring-head* of a custom-designed magnetic reader device enables isothermal amplification by applying steady temperatures (~65°C) as well as sensitive readout of the magnetic labels by *frequency magnetic mixing detection* (FMMD). By combining amplification and detection in one measuring device, no additional laboratory equipment is required. As a next step, we emphasize to realize antibiotic resistance detection through the use of magnetically labeled nanoprobes that hybridize the amplificate. Future work aims to streamline the overall process by performing the amplification, labeling, and detection in one filter matrix.

The compact design of the handheld magnetic reader enables easy application directly in poultry facilities, facilitating rapid on-site analyses for timely and effective treatment. The platform developed in this study offers

extensive applications in nucleic acid-based pathogen detection. Its advantages can be transferred into further agriculture fields as wells as medical diagnostics.



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Krause, Hans-Joachim; Wolters, Norbert; Zhang, Yi; Offenhäusser, Andreas; Miethe, Peter; Meyer H.F., Martin; Hartmann, Markus; Keusgen, Michael (2007): Magnetic particle detection by frequency mixing for immunoassay applications. In: Journal of Magnetism and Magnetic Materials 311 (1), S. 436–444. DOI: 10.1016/j.jmmm.2006.10.1164. Patent application number: EP24153492.4 - Apparatus and Method for Combined Amplification and Detection of a Solution

Topics

Point-of-care

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5th European Biosensor Symposium

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Abstract Title:

A nanochannel-based electrochemical platform for real-time screening of antibiotics in bacterial cultures

Abstract body:

Antibiotic resistance is a critical global health concern [1], creating an urgent need for the development of novel therapeutic agents. As traditional approaches present limitations due to their time-consuming nature or limited sensitivity [2], new tools are needed to evaluate antibiotic efficacy in real time. Biosensors, especially electrochemical ones, offer promising alternatives due to their speed, sensitivity, and compatibility with point-of-care formats [3]. However, most platforms lack biocompatibility for live bacterial monitoring.

To address this, we have developed a biocompatible electrochemical system capable of detecting secreted virulence factors in real time, enabling *in vivo* dynamic assessment of the interaction between the therapeutic agent and the virulence factor. The system uses nanoporous alumina membranes functionalized with specific anti-virulence factor antibodies and integrated with biocompatible indium tin oxide (ITO)-coated PET electrodes [4]. Bacteria are cultured directly above the membrane together with a non-toxic redox indicator. Secreted virulence factors block redox transport through the nanochannels, which is continuously monitored via chronoamperometry [5].

We validated the platform using *Staphylococcus aureus*. Redox indicators were tested for compatibility with bacterial viability and electrochemical sensitivity. Optimal combinations allowed sustained monitoring over hours without toxic effects. The system reliably detected virulence factor secretion and its modulation in the presence of antibiotics, enabling time-resolved analysis of therapeutic activity directly in culture, without additional labeling or sample handling.

This biocompatible electrochemical platform enables real-time evaluation of anti-virulence therapeutics in live bacterial cultures. Its sensitivity, simplicity, and dynamic readout make it a promising tool for accelerating antimicrobial screening, especially for compounds targeting pathogenicity rather than viability, positioning it as a relevant tool in the fight against antibiotic resistance.

Abstract References

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Acknowledgements: The financial support of Grants MCINN-24-PID2023-149004OB-I00 and RED2022-134120-T, funded by MCIN/AEI/10.13039/501100011033 and by ERDF A way of making Europe; and of Grant SEK-25-GRU-GIC-24-071 funded by the Asturias Regional Government, is gratefully acknowledged.

Topics

Point-of-care

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

A novel LAMP method to produce DNA nanoballs: optimization, characterization and application to clinical pathogens via impedance analysis

Abstract body:

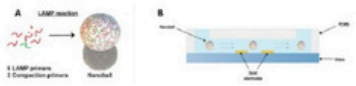
Fast and accurate detection of nucleic acids is key for pathogen identification, with applications spanning infectious disease diagnostics, food safety, and environmental monitoring. Traditional DNA detection methods often rely on multi-step, label-based fluorescent or colorimetric readouts, which increase assay complexity and duration. Label-free approaches offer the potential to simplify workflows and accelerate turnaround times, making them more suitable for point-of-care (POC) applications.

Our group developed a novel loop-mediated isothermal amplification (LAMP) method to be able to generate DNA nanoballs during the DNA amplification process.1 We modified the LAMP by incorporating compaction oligonucleotides, which self-assemble the amplified target into large (~1 µM) DNA nanoballs (Figure 1A). We optimized the reaction parameters (including probe ratio, sequence repetition, and probe modification) to maximize both amplification efficiency and nanoball yield and size. Dynamic Light Scattering was used to characterize nanoball size and stability, revealing that magnesium ion supplementation enhances structural integrity.

We integrated this isothermal DNA nanoball generation with a label-free detection platform based on electrical impedance.[1] As a proof of concept, the method successfully detected SARS-CoV-2 RNA and was further validated using heat-inactivated upper-airway clinical samples. The system detected as few as 10 target copies and showed strong agreement with RT-qPCR results. We further demonstrated the versatility of the method by detecting various DNA and RNA targets of viral and bacterial origin, including HIV, Influenza A, the β-lactamase gene, and *Mycobacterium*.

This method represents a potentially sensitive, low-cost (<$5), rapid (<60 min), and scalable POC solution for pathogen detection. Ongoing work aims to enhance specificity, enable multiplex detection, and integrate the

system into a standalone diagnostic device.

Figure 1. Impedance-based electric detection of DNA nanoballs. A) Formation of DNA nanoballs using compaction oligos. B) Scheme of simplified microfluidic device. 

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Topics

Point-of-care

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Abstract Title:

A Point-of-Care (POC) biosensor for the early diagnosis of leprosy through human serum analysis

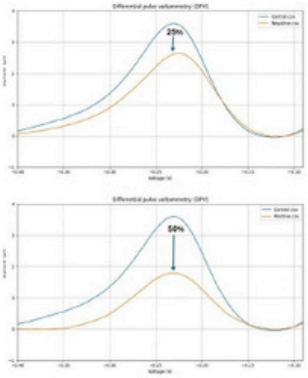
Abstract body:

Introduction: In this study, we developed a novel point-of-care (POC) biosensor designed for the early detection of leprosy before the manifestation of clinical symptoms. Leprosy is a neglected tropical disease (NTD) caused by the acid-fast bacilli (AFB) of the Mycobacterium leprae complex [1], affecting the skin, peripheral nerves, mucosa of the upper respiratory tract, and eyes [2]. According to the World Health Organization (WHO), approximately 200,000 cases of leprosy are reported annually in more than 120 countries [3]. However, leprosy is curable, and various studies [4], [5], [6] show a connection between the severity of disabilities and delays in diagnosis, which occur in 60-70% of patients [7].

Materials and Methods: We developed a self-assembled monolayer (SAM) on a screen-printed gold electrode (SPGE), including a peptide previously designed by a partner research group to detect leprosy IgG and IgM [8]. One extremity of the peptide was modified with methylene blue (MB) as a redox probe. 6-mercapto-1-hexanol (C6-OH) has been used as a backfill agent to minimize non-specific adsorption and to preserve the proper orientation of the immobilised peptide on the gold surface.

Results: Figure 1 shows the variation in MB current upon interrogation of the sensor with sample matrices, including buffer solutions, human plasma samples from healthy individuals, and plasma samples from individuals classified as "contacts"—typically family members of leprosy patients. These contacts are asymptomatic but exhibit the presence of specific antibodies as determined by conventional enzyme-linked immunosorbent assay (ELISA). The positive samples resulted in a decrease of MB current, which was double that of the negative sample with respect to the control.

Conclusions: This electrochemical biosensor addresses the need for a POC device that allows for fast, affordable, and early detection of leprosy, helping to prevent severe disabilities associated with the disease's symptoms.



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Topics

Point-of-care

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5th European Biosensor Symposium

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Abstract Title:

A portable all-in-one device for DNA pathogen detection applied to aquaculture surveillance

Abstract body:

Background. Effective disease management in aquaculture, particularly for high-production fish like gilt-head bream, or high-value species such as bluefin tuna, is critical for improving fish welfare and reducing economic losses caused by infections. Current diagnostic methods are often labor-intensive, time-consuming, and require specialized personnel and equipment, making them unsuitable for rapid on-site detection. This communication presents the development of portable devices and easy-to-apply DNA-based methodologies for detecting relevant fish pathogens.

Materials & methods. The studied targets were the bacteria *Vibrio*, and the parasites *Cardicola* and *Enteromyxum leei*. Portable fast isothermal DNA techniques were developed for selective biorecognition of specific genes. Integrated optical transduction was employed to detect DNA products.

Results. A specific strip and cassette were developed for amplification-lateral flow assay, enabling user-friendly identification based on the visualization of a colored band. For quantitative applications, a microfluidic chip was designed and tested. The setup includes a portable heating system and controlled illumination for smartphone-based reading. Both prototypes have been validated using samples collected from infected fish. The method achieved a detection limit of 100 copies/mL and showed reproducibility with a standard deviation typically ranging from 5% to 15%. Results confirmed that developing a robust DNA-based method for pathogen detection in aquaculture facilities significantly enhances disease management by enabling rapid, accurate, and highly sensitive identification of causative agents.

Conclusions. Though DNA-based biosensing presents a promising alternative in sensitivity and selectivity, it necessitates specific advancements for rapid, field-based diagnostics and extensive surveillance. Our innovation facilitates timely intervention and, ultimately, more sustainable and productive aquaculture.

Acknowledgments. Spanish MICIU (Ministerio de Ciencia, Innovación y Universidades) with funding from European Union NextGenerationEU (PRTR-C17.I1) and by Generalitat Valenciana

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Topics

07 Point-of-care -

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

An Electrochemical Biosensor for Detection of Cancer Biomarkers and Extracellular Vesicles isolated from Lung Cancer

Abstract body:

Lung cancer remains a leading cause of cancer-related mortality worldwide. Symptoms seldom manifest until the disease is already in its advanced stage. This makes it extremely hard to detect and survival chances are weak. Early diagnosis is desired to improve a patient's survival and quality of life.

Nature's own nanoparticles, known as extracellular vesicles (EV), offer a promising alternative as they have proven potential for novel biomedical applications. They are nano-sized particles (<50 to 200 nm) released by all cells and are found in various bodily fluids. EVs provide ideal targets for early detection as they inherit and transport "cargo" molecules such as transmembrane proteins from their cells of origin. As they were found in exhaled breath, they offer a much-desired non-invasive diagnostic approach.

In this project, we devised an electrochemical biosensor platform to capture EVs by immobilising aptamers on gold surfaces. This modification rendered the surfaces useful as sensing electrodes in electrochemical measurements. Modified electrodes were used as sensor platforms in electrochemical impedance spectroscopy (EIS) measurements. Using optimised platforms, capture of EV isolated from non-small cell lung cancer (NSCLC) cell line generated calibration plots with low detection limits of < 10 particles per mL. Complementary data from surface plasmon resonance (SPR) and circular dichroism spectroscopy (CD) measurements further confirmed binding, indicating a target-induced mechanism.

To explore further, a portable prototype was fabricated by transferring the platform to lithographically patterned planar gold electrodes. Lung cancer-derived EVs were detected in a shorter time using a tiny sample volume. The aptasensor offers an alternative route for lung cancer screening, a simple, non-invasive, rapid and inexpensive complement to current diagnoses involving biopsy or bronchoscopy. Future efforts

targeting a cocktail of biomarkers are expected to improve sensitivity and selectivity, removing cross-sensitivity to other. Future development could see this platform integrated into a disease breathalyser.

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Topics

Point-of-care

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5th European Biosensor Symposium

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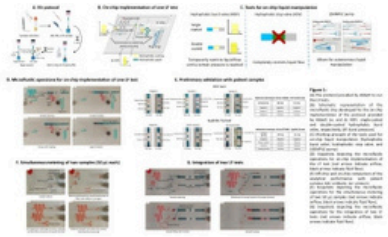
Abstract Title:

Autonomous microfluidic point-of-care device for the simultaneous screening of HIV and Syphilis Tp

Abstract body:

Over the past decades, a growing effort was made to bring lab-quality assays to decentralized locations, collectively known as point-of-care (POC). A combined POC test for the detection of HIV and Syphilis Tp is highly desired because of (1) an increased risk of co-infection among certain populations (e.g., men having sex with men) and (2) the WHO recommendation to reduce congenital syphilis in antenatal care[1-3]. The current combined POC tests have multiple user-dependent steps (Figure 1A) and can only detect HIV-1/2 antibodies, without the HIV p24 antigen, thereby prolonging the diagnostic window. We aim to develop a rapid, user-friendly POC test for HIV and Syphilis Tp screening by integrating commercial lateral flow (LF) tests (i.e., the DETERMINE™ HIV Early Detect and DETERMINE™ Syphilis Tp, Abbott) with our in house developed self-powered (i)SIMPLE microfluidic technology[4-5]. To achieve this, we developed several on-chip elements: a sample metering unit (for accurately metering 50 µL of sample), a chamber for housing the commercial LF strip, a storage unit for chase buffer (necessary for running the bioassay), and a plug timer for the sequential delivery of sample and chase buffer (Figure 1B-D). The microfluidic chips were fabricated using a rapid layer-by-layer assembly of patterned double-sided pressure-sensitive adhesive that holds the channel network and polyethylene terephthalate and/or polymethylmethacrylate sheets[4-8]. Analytical validation with patient samples (two positive for HIV and three positive for Syphilis), benchmarked with the reference technique (Vitros XT5600 – HIV Combo test and Vitros XT5600 – Syphilis Tp test), showed no difference between the off-chip and on-chip performance (Figure E). The ongoing work is focused on integrating both the HIV and Syphilis LF strips on a single microfluidic chip, together with the self-powered (i)SIMPLE pump for autonomous liquid handling, which will be followed by analytical validation with a larger sample set (Figure 1F-G).



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Topics

Point-of-care

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Abstract Title:

Bioanalytical Sutures for In-Situ Monitoring of Wound Biomarkers

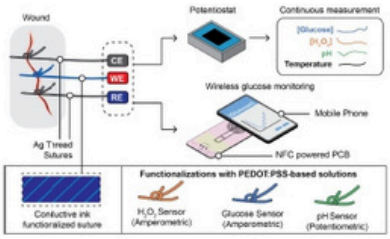
Abstract body:

Background: Traditional diagnostic techniques fall short in providing real-time, localized biochemical data from deep tissue wounds. While implantable bioelectronic devices offer high-resolution monitoring, rigid electrodes and RF-based readouts risk infection and signal degradation in heterogeneous tissue. Flexible electrochemical sensors made from soft, biocompatible materials provide a promising alternative for in situ analysis. Here, we a suture-based biosensing platform that integrates real-time wound monitoring with standard clinical practice. Inspired by textile-integrated electronics[1] and leveraging conductive polymer-coated threads[2], SensStitch enables localized sensing without compromising wound integrity.

Materials & Methods: Cotton sutures were functionalized with conductive polymer inks comprising PEDOT:PSS[3] and carbon-Prussian Blue composites. These threads were engineered to detect peroxide, glucose, pH, ionic concentrations, and temperature. Sensor validation was conducted in buffer solutions, ex vivo (chicken muscle), and in vivo (murine and rat) models.

Results: The sutures demonstrated high sensitivity and selectivity for each biomarker across physiologically relevant ranges. Electrochemical performance was stable under mechanical deformation and biological conditions. Ex vivo and in vivo testing confirmed successful signal acquisition with minimal tissue interference. Additionally, a wireless transmission module was integrated to enable proof-of-concept real-time remote data acquisition. The system maintained functional integrity during suturing and tissue integration. Multi-analyte sensing from a single fiber bundle enabled robust wound state profiling over time, including inflammation markers and healing progression indicators.

Conclusions:The developed sutures offers a soft, minimally invasive platform for continuous monitoring of deep tissue wound biochemistry. This work introduces a promising direction for intelligent wound care, combining conventional suturing with electrochemical sensing to provide clinicians with actionable, real-time data for tailored therapeutic interventions.



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Topics

07 Point-of-care -

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5th European Biosensor Symposium

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Abstract Title:

Bio-Inspired Receptors on Laser-Induced Graphene electrodes for Chronic Disease Monitoring

Abstract body:

Growing demand for affordable, durable biosensors drives interest in synthetic receptors as alternatives to biological recognition elements. These systems offer customizable binding properties and mechanical robustness, ideal for wearable devices operating under dynamic conditions. Concurrently, manufacturing needs are advancing techniques like laser-induced graphene (LIG), where polyimide films are converted into conductive circuits via low-power lasers. LIG's adaptability enables integration with flexible/rigid substrates, meeting wearable electronics' mechanical requirements.

This study investigates coupling synthetic bio-inspired receptors with LIG electrodes to develop low-cost sensing systems for chronic disease biomarkers. Key challenges include optimizing receptor immobilization on LIG's heterogeneous surfaces without compromising electrochemical performance; ensuring selectivity in complex biological fluids; and maintaining functionality under mechanical stress. Through systematic evaluation of adhesion strategies and operational stability, we identify design principles to enhance sensitivity and durability.

Our findings establish a framework for hybrid synthetic receptor-LIG systems, bridging high-affinity molecular recognition and scalable electronics for next-generation wearable diagnostics in personalized healthcare.

Abstract References

Acknowledgements This work was supported by the Aventis Foundation (Project number: 80304368), Joachim Herz Foundation (Project number: 803043), and European Union by the NextGenerationEu project ECS00000017 'Ecosistema dell'Innovatione' Tuscany Health Ecosystem (THE, PNRR, Spoke 3: Nanotechnologies for diagnosis and therapy).

Topics

Point-of-care

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Calorimetric Lateral Flow Immunoassay for the Detection of miRNAs associated to Pancreatic Cancer using Triangular Au Nanoparticles.

Abstract body:

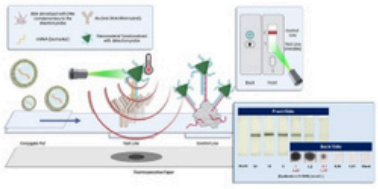
Pancreatic ductal adenocarcinoma (PDAC) is one of the leading causes of cancer-related deaths due to its late diagnosis, limited treatments, and poor response to available therapies[1]. Among the main intercellular communication mechanisms of tumoral cells, **extracellular vesicles (EVs)** play a fundamental role in tumor development, cell growth, metastasis, and chemoresistance. Thus, EVs have emerged as important membrane-enclosed messengers containing biomolecules which provide information about the physiological cell state, cancer progression, metastasis, and tumor-stroma interactions.

On this basis, **biomarkers** (e.g., **miRNAs**) contained inside EVs can be used not only to detect PDAC at an early stage but also to monitor the efficacy of current and novel therapies. To achieve this purpose, we propose the use of inorganic nanomaterials with appropriate physicochemical and optothermal properties[2,3].

Hence, **Au nanoparticles (AuNPs)** with a surface plasmon resonance are among the best candidates. Their combination with Rapid Diagnostic Tests (RDTs), such as lateral flow immunoassays (LFIA), can lead to highly specific and ultrasensitive **point-of-care biosensing systems**[4].

In this work, we describe the surface biofunctionalization of 150 nm Au Nanoprisms (λmáx= 1100nm) with specific DNA probes to detect PDAC-associated miRNAs. These nanoconjugates act as signal enhancers and thermal transducers due to their capacity to generate heat upon LASER irradiation[5-7]. When the nanoconjugates bind the target miRNA, an antibody on the nitrocellulose strip recognizes the nucleotide hybrid. After recognition, **irradiation with a NIR LASER** creates a visible spot on the thermosensitive paper attached to the strip, which can be quantified by image (LoDvisual = 5 $fmol_{miRNA}/uL_{sample}$). Furthermore, our

sensor has been tested on **EVs isolated from immortalized pancreatic cell lines**, showing excellent concordance with qRT-PCR-based quantification. This method offers clear benefits regarding lower cost, shorter assay time, and simpler handling compared to qRT-PCR. In future work, the generated heat will be exploited for novel signal-enhancement strategies.



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Topics

Point-of-care

Luna Pozo, Antonio Jesús; García Barrientos, África; beola Guibert, Lilianne de la caridad; Cuestas Ayllón, Carlos; Grazú Bonavía, Valeria; Martínez de la fuente, Jesús
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POSTER

5th European Biosensor Symposium

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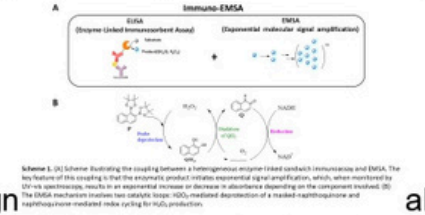
Abstract Title:

Design of molecular probes for enzyme-free Exponential Molecular Signal Amplification (EMSA)

Abstract body:

Rapid and reliable detection of ultralow-abundance targets has received great attention due to increasing demand in clinical diagnostics and biotechnology development. What limit the detection of ultralow-abundance biomolecules are the slow mass transport and weak binding kinetics at ultralow concentration of target biomolecules, thus amplification of signal has to play an essential role. Currently, immunoassays are valued for their high specificity and relies on enzymatic processes for either linear signal amplification (ELISA) or exponential signal amplification (immuno-PCR), which have many inherent issues restricting their implementation in point-of-care diagnostics, including high cost, complex procedure and lack of robustness. As a substitute approach, we designed an enzyme-free signal exponential amplification strategy, i.e. Exponential Molecular Signal Amplification (EMSA), which is based on two molecular catalytic loops that activate each other to create an exponential amplification power.



Using H_2O_2 as a model target, our latest design employs a double protected boronate ester probe based on 1,2-naphthoquinone (1,2-NQ), which enables the detection of H_2O_2 at sub-micromolar concentrations in the presence of a reducing agent (NADH), without the need for enzymes. Notably, the addition of calcium significantly promotes the oxidation process, considerably reducing the response time.

This promising chemical amplification strategy thereby expands the toolbox for the detection of trace amounts of biotargets, because of its simple composition, ease of operation, low cost, and universal applicability if

coupled with biorecognition event.

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[1] Chemistry - A European Journal 2019, 25 (31), 7534-7546. [2] Chemical Communications 57.86 (2021): 11374-11377 [3] Chemical Science 13.9 (2022): 2764-2777

Topics

Point-of-care

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Abstract Title:

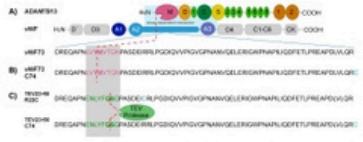
Development of a magnetic beads assay for the detection of ADAMTS13 proteolytic activity

Abstract body:

Background:

High sensitivity and specificity are common requirements for diagnostic biosensors. A clinically relevant target needing better analytical strategies is the protease "**A** **D**isintegrin **A**nd **M**etalloprotease with **T**hrombo**S**pondin repeats **13**" (ADAMTS13), catalyzing proteolytic cleavage of the von Willebrand factor (vWF) (Fig.A). Insufficient ADAMTS13 activity leads to ultra-large vWF multimers, causing the life-threatening thrombotic thrombocytopenic purpura (TTP) [1]. However, determination of ADAMTS13 activity is often restricted to specialized laboratories, delaying optimal treatment [2].

To accelerate TTP diagnosis, we aim to develop a magnetic bead assay for detecting ADAMTS13 activity at the point-of-care.



Methods:

Peptides (Figs.B+C) were expressed in *E. coli*, purified via liquid chromatography, labeled at cysteines with maleimide-C5-fluorophores, and N-terminally coupled to magnetic beads. To assess protease activities, peptide-coupled beads were incubated with respective proteases, and samples collected over time. The

supernatant, containing cleaved, fluorophore-labeled peptide fragments, was analyzed by fluorescence measurements.

Results:

Using the proof-of-concept peptides (Fig.C) covalently coupled to epoxy-activated magnetic beads, the bead assay could be optimized in terms of peptides:beads ratio and positioning of the fluorophore label. After successful optimization, the assay was initially tested for detection of ADAMTS13 activity, using the modified vWF73 peptide (Fig.B) as substrate and commercial or recombinant ADAMTS13, or healthy donor plasma as sample. The preliminary data showed promising results, although some of the peptides were probably coupled via primary amino groups of the fluorophore rather than via their N-terminus to the beads, meaning that their digestion could not be detected.

Conclusion:

The beads assay has the potential to be a valuable tool for the diagnosis of TTP, but also other diseases with impaired protease function, in the future.

Next, N-terminally Twin-Strep-tagged peptides will be generated, enabling specific non-covalent binding of substrate peptides to magnetic beads for further assay improvement.

Abstract References

[1] Crawley JT, Scully MA. Hematology (Am. Soc. Hematol. Educ. Program 2013), 2013, 292. [2] Bommer M, Wölfle-Guter M, Bohl S, Kuchenbauer F. Dtsch. Arztebl. International 2018, 115, 327.

Presentation Preference

Poster

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5th European Biosensor Symposium

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Abstract Title:

Development of a multiplexed lateral flow immunoassay for dry eye disease diagnosis.

Abstract body:

Background

Dry eye disease (DED) is a chronic and progressive condition of the ocular surface characterized by tear film instability. It represents a major public health-care concern with a high worldwide prevalence around 12%. Diagnosis is complex due to the poor correlation between symptoms and clinical signs, leading to frequent misdiagnosis in early stages and worsening of patient quality of life. Current diagnostic tests do not enable to properly stratify disease severity. This work aims to develop a multiplexed lateral flow immunoassay (mLFIA) for the rapid detection of a panel of biomarkers to enable accurate DED diagnosis, staging, and treatment monitoring.

Methods

A predictive model based on data from 300 patients enabled biomarker selection for mLFIA development. Antibodies were characterized by ELISA and individual LFIAs optimized using anti-biotin IgG-AuNP conjugate. The final multiplexed device included three different test lines and a control, and was evaluated in healthy tear samples (CT) using a single dilution (2 uL) in optimized running buffer.

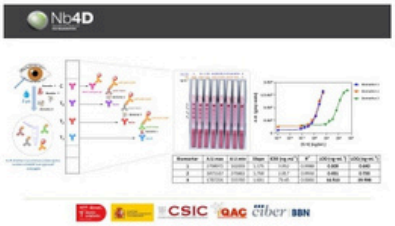
Results

Capture and detection antibodies were selected based on best detectability (LOD: B1 = 6.1 pg/mL, B2 = 2.1 pg/mL, B3 = 5.9 pg/mL), ensuring specificity and compatibility to be used as an antibody cocktail. Matrix effect in artificial tears showed optimal performance at 1:25 dilution. The most sensitive LFIA strategy used an anti-biotin polyclonal antibody-AuNP conjugate. After optimization, calibration curves in 1:25 diluted CT enabled detection of the three biomarkers. The mLFIA achieved high sensitivities (LOD: B1 = 0.31 ng/mL,

B2 = 0.45 ng/mL, B3 = 16.5 ng/mL) and the final prototype was tested with DED patient samples (N=5), showing clear differences from healthy controls (N=5).

Conclusions

A mLFIA have been developed for the simultaneous detection of three biomarkers in human tears. The LOD's achieved from both individual assays and multiplexed assay are below those previously reported, demonstrating the potential of this prototype as a point-of-care (PoC) tool for diagnosing and assessing the severity of DED.



Abstract References

No references

Topics

Point-of-care

Rodríguez-Núñez, Montserrat[1]; Enríquez-de-Salamanca, Amalia[2]; González-García, María Jesús[2]; Fernández, Itziar[2]; Calonge, Margarita[2]; Martin-Toribio, Alejandro[2]; García-Vázquez, Carmen[2]; Salvador, J.-Pablo[1]; Marco, M.-Pilar[1]

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5th European Biosensor Symposium

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Abstract Title:

Development of a portable measurement platform for capacitive field-effect biosensors

Abstract body:

Introduction

The lack of portable, user-friendly and low-cost measurement systems often prevents the use of in-field biosensors. Here we, present the development and validation of a portable measurement platform for capacitive field-effect sensors with an electrolyte-insulator-semiconductor (EISCAP) architecture. The system is based on the "Emstat Pico" chip of PalmSens adapted for both single and multiplexed sensor analysis by impedance spectroscopy, capacitance-voltage and constant-capacitance mode measurement via a user interface written in Python.

Results

The system performance was benchmarked against a stationary high-end impedance analyzer (IM6ex from Zahner-Elektrik) using Ta_2O_5-gated EISCAP pH sensors with nearly Nernstian pH sensitivities for both platforms, demonstrating that the portable setup can achieve laboratory-grade precision [1,2,3]. With the single-sensor setup, penicillinase-modified sensors enabled quantification of penicillin concentrations between 0.2 and 2 mM, with sensitivities of about 100 mV/dec [1,3]. Expansion of the platform to a 16-channel setup was achieved by integrating the EmstatPico MUX16 development platform with a multi-sensor setup for EISCAPs [2,4,5]. A novel application was demonstrated for detecting C-reactive protein (CRP) using antibody-functionalized magnetic microparticles in a field-effect sensor-based on-chip enzyme-linked immunosorbent assay (ELISA) [5]. The oxidation of ABTS by HRP consumes protons. The local pH change is detected by the sensors. CRP concentrations between 0.05 mg/L up to 50 mg/L were tested, with a maximum signal of ~20 mV recorded for 50 mg/L CRP and were referenced against an optical assay.

Conclusions

In conclusion, our portable platform delivers reliable, high-performance sensor characterizations in compact formats. The portability, accuracy, and user-friendly design make it a promising start for in-field measurements with capacitive field-effect sensors.

Acknowledgements

Part of this work was supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation, grant 445454801).

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Topics

Point-of-care

Karschuck, Tobias[1]; Schmidt, Stefan[2]; Achtsnicht, Stefan[3]; Ser, Joey[3]; Bouarich, Ismail[3]; Aboutass, Georges[3]; Poghossian, Arshak[4]; Wagner, Patrick H.[5]; Schöning, Michael J.[6]

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5th European Biosensor Symposium

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Abstract Title:

Development of a Rapid and Specific Biosensor for the Detection of Pseudomonas aeruginosa in Clinical Samples

Abstract body:

Diseases caused by bacterial infections are the second leading cause of mortality according to the World Health Organization (WHO), with more than 15 million deaths annually worldwide, only preceded by cardiovascular diseases. Considering the dramatic increase in resistance to existing antibiotics, these have become an emerging global threat. For this reason, developing new diagnostic systems that are fast, cheap, robust, and easy to use, capable of quickly detecting different pathogens, is a priority to achieve early diagnosis, appropriate treatment, and thereby the possibility of reducing the mortality associated with bacterial infections.

With this in mind, this work has developed a biosensor based on molecular gates for the specific detection of Pseudomonas aeruginosa in less than 30 minutes. This pathogen is extremely problematic in intensive care units. The high morbidity and mortality of its infections, especially in people with respiratory diseases, and its high capacity to present multi-resistance to antibiotics explain why it has been classified as a 'Highly Priority Pathogen' by the World Health Organization since 2024. The detection system consists of anodic nanoporous alumina (AAN) plates whose porous interior has been loaded with the fluorescent indicator rhodamine B and capped with oligonucleotides capable of specifically and selectively recognizing the phzA2 gene of P. aeruginosa when present. This procedure has shown successful results in discriminating clinical samples from healthy patients and those infected with the bacteria in a short time with high sensitivity (detection limit of 30 CFU mL^{-1}) and specificity compared to conventional low-cost detection techniques, which represents a diagnostic advantage for its clinical implementation and the prevention of increased resistance acquired by P. aeruginosa. On the other hand, the sensor material has also been incorporated into test strips offering a response in just one minute, with sensitivity and specificity levels similar to those obtained in solution.

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Topics

Point-of-care

Climent Terol, Estela[1]; Torres Mesado, Andrea[1]; López Palacios, Alba[2]; Caballos Gómez, María Isabel[1]; Hernández Montoto, Andy[2]; Tormo Mas, María Ángeles[3]; Aznar Gimeno, Elena[2]; Martínez Máñez, Ramón[2]

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POSTER

5th European Biosensor Symposium

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Abstract Title:

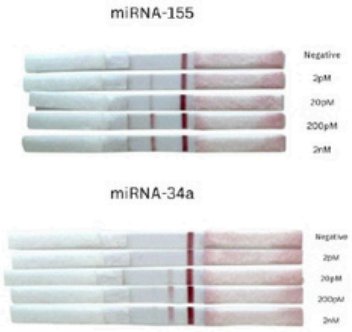
Development of lateral flow assays for the point-of-care detection of cardiovascular biomarkers

Abstract body:

Cardiovascular diseases remain the leading cause of morbidity and mortality worldwide, demanding early and accessible diagnostic tools. In this work, we present the development of two different lateral flow assay (LFA) platforms for the detection of NT-proANP and microRNAs (miR-34a and miR-155), key biomarkers associated with cardiovascular stress, atrial fibrillation, and early-stage heart failure. To enhance sensitivity and address the inherent limitations of conventional LFAs, we integrated a pre-amplification step using rolling circle amplification (RCA) for nucleic acid targets, enabling femtomolar detection limits without complex instrumentation.

In our biosensor design for NT-proANP, a paper-based LFA was developed and optimized for detection using a pair of antibodies and colloidal gold labeling (sandwich assay). The resulting platform achieved a limit of detection (LOD) of 10 ng/mL, which falls within the clinically actionable range for AF screening and demonstrates potential as a rapid, equipment-free diagnostic tool; and for miRNAs, the amplification step is done in solution. Gold nanoparticle-detection probe conjugates specific to miRNA-34a and miRNA-155 are immobilized onto the conjugate pad of the LFA strip, and biotinylated DNA probes specific to miRNA-34a and miRNA-155 are immobilized onto the test lines of the LFA strip. After the amplification step of the target sample, the product is applied to the LFA strip, allowing the semi-quantitative measurement of the target concentration in 15 minutes.

In the images, we show the performance of the lateral flow assay (LFA). The assay demonstrated the capability to detect miRNA-34a and miRNA-155 at a concentration of 20 pM and 2 pM respectively. Additionally, we have successfully integrated both test lines to enable the simultaneous detection of multiple miRNAs on a single strip, enhancing the assay's multiplexing capability.



Abstract References

[1]. Fluorescent microspheres lateral flow assay integrated with Smartphone-based reader for multiple microRNAs detection. Fanglan He, Xuefei Lv, Xiaoqiong Li, Mengdi Yao, Kunjie Li, Yulin Deng. 2022, p. 107551. [2]. Highly sensitive and portable mRNA detection platform for early cancer detection. Hongxia Li, Antony R. Warden , Wenqiong Su, Jie He, Xiao Zhi, Kan Wang, Laikuan Zhu, Guangxia Shen and Xianting Ding. 2021, p. 19:287. [3]. Sensitive detection of microRNA-21 in cancer cells and human serum with Au@Si nanocomposite and lateral flow assay. Tao Dong, Ran Yin, Qingcai Yu, Wanwei Qiu , Kun Li , Lisheng Qian, He Li, Bing Shen, Guodong Liu. 2021, pp. 56-63. [4]. Visual detection of microRNA with lateral flow nucleic acid biosensor. Xuefei Gao, Hui Xu, Meenu Baloda, Anant S. Gurung, Li-Ping Xu, Tao Wang, Xueji Zhang, Guodong Liu. 2014, pp. 578–584.

Topics

Point-of-care

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Electrically Readable Lateral Flow Assay Using Organic Transistors for Hepatitis B and C detection

Abstract body:

Viral hepatitis, particularly infections caused by hepatitis B (HBV) and hepatitis C (HCV), remains a global health challenge due to their high potential to cause chronic liver disease, cirrhosis, and even death [1]. Early diagnosis is crucial, but current testing methods are often expensive and complex, limiting timely detection and access to treatment. To address this gap, there is growing interest in electrolyte-gated organic field-effect transistors (EGOFETs) as highly sensitive, label-free biosensors [2,3]. However, their use in portable diagnostics is hindered by challenges in microfluidic integration and reliance on multi-step, ex-situ assays. On the other hand, paper-based lateral flow (LF) immunoassays are widely adopted for point-of-care (PoC) diagnostics due to their simplicity and low cost, though their sensitivity is constrained by optical detection limitations. This work introduces a novel diagnostic platform that integrates EGOFETs with LF paper fluidics, resulting in a reusable, portable, and cost-effective PoC test capable of delivering results in approximately 20–30 minutes. The system was validated for detecting key hepatitis biomarkers, demonstrating a broad linear range, high selectivity, reproducibility, ultra-low detection limit upper than femtomolar range and values of sensitivity, specificity and accuracy upper than 95%. A custom-designed prototype featuring a miniaturized electronic reader—operable via a USB-connected smart device—highlights the system's portability. This approach meets critical criteria for affordable PoC diagnostics and paves the way for the next generation of digital lateral flow assays.

Abstract References

[1] "World Hepatitis Summit 2022 statement," https://www.who.int/news/item/10-06-2022-world-hepatitis-summit [2] Ricci, S., Casalini, S., Parkula, V., Selvaraj, M., Saygin, G. D., Greco, P., Biscarini, F., & Mas-Torrent, M. (2020). Label-free immunodetection of α-synuclein by using a microfluidics coplanar electrolyte-gated organic field-effect transistor. Biosensors and Bioelectronics, 167, 112433. https://doi.org/10.1016/j.bios.2020.112433 [3] A. Paradisi, M. Berto, M. Di Giosia, S. Mazzali, M. Borsari, T. D.

Marforio, F. Zerbetto, M. Calvaresi, A. Orieshyna, N. Amdursky, C. A. Bortolotti, F. Biscarini, Chem. Eur. J. 2023, 29, e202301704.

Topics

Point-of-care

Ortiz Aguayo, María Jesús[1]; Martínez - Domingo, Carme[2]; Kos, Dean[1]; Gutiérrez Yatacue, Diego[1]; Mas - Torrent, Marta[1]
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5th European Biosensor Symposium

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Abstract Title:

Electrochemical Genosensor for IFNγ mRNA Detection in HLA-DR+ Exosomes: A Tool for Immune Monitoring

Abstract body:

The development of biosensing platforms capable of detecting nucleic acid biomarkers within extracellular vesicles (EVs) is a growing field with relevance for immunodiagnostics [2-5]. In this work, an electrochemical genosensing strategy is presented for the detection of interferon-gamma (IFNγ) mRNA in exosomes secreted by activated immune cells. The method integrates an immunomagnetic separation step using HLA-DR-specific antibodies to selectively isolate MHC class II-positive exosomes from peripheral blood mononuclear cell (PBMC) cultures. This affinity-based isolation enhances target concentration and specificity while avoiding labor-intensive ultracentrifugation. The molecular detection relies on reverse transcription followed by a double-tagged endpoint PCR amplification, in which primers are labeled with biotin and digoxigenin (DIG). The resulting amplicons are preconcentrated on streptavidin-coated magnetic particles through the biotin label. Electrochemical detection is subsequently performed via an anti-DIG antibody conjugated to horseradish peroxidase (HRP), enabling enzymatic signal generation on a screen-printed electrode [3-5]. The platform enables the detection of IFNγ mRNA with improved sensitivity when analyzing HLA-DR+ exosome-enriched samples compared to total extracellular RNA preparations. The housekeeping gene GAPDH was simultaneously used as an internal reference to validate the assay performance. This approach demonstrates the feasibility of combining immunoaffinity exosome isolation with electrochemical nucleic acid sensing, offering a modular strategy for the detection of immune-related gene expression signatures in extracellular vesicles.

Abstract References

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Jan. 2023, doi: 10.1021/acs.analchem.2c04773. 3- S. L. Moura, et al, "Multiplex detection and characterization of breast cancer exosomes by magneto-actuated immunoassay," Talanta, vol. 211, May 2020, doi: 10.1016/j.talanta.2019.120657. 4- M. Bernuz et al, "Magnetic Separation of Cell-Secreted Vesicles with Tailored Magnetic Particles and Downstream Applications," 2023, pp. 257–276. doi: 10.1007/978-1-0716-3203-1_18. 5- A. Pallares-Rusiñol et al., "Advances in exosome analysis," 2023, pp. 69–117. doi: 10.1016/bs.acc.2022.09.002. strategy for the detection of immune-related gene expression signatures in extracellular vesicles.

Topics

Point-of-care

Del Valle, Anaixis[1]; Rossi, Rosanna[1]; Bulfoni, Camila[2]; Mesas Gómez, Melania[3]; Martí, Mercè[1]; Pividori, Maria Isabel[1]

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5th European Biosensor Symposium

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Abstract Title:

Electrochemical Lateral Flow Assays: Current Advances and Future Directions in Portable Biosensors

Abstract body:

Lateral flow assays are perhaps the most widely used point-of-care biosensing platform in the world. While they meet all the WHO's ASSURED criteria, they suffer from several limitations, including binary signal outputs, semi-quantifiable readouts and relatively poor limits of detection.(1) To address these concerns, there has been much research into the development of next generation LFAs. One type of which is the integration of electrodes into LFAs to develop electrochemical LFAs. These address many of the issues associated with LFAs. Recently we have developed a method of nanoelectrode fabrication that can be done outside of the cleanroom.(2) Nanoelectrodes have enhanced signal to noise ratios over larger electrodes, so can achieve sub atto-Molar (10-18 M) limits of detection. In this work we have integrated these nanoelectrodes into LFAs to make nano-eLFAs, a new next-generation biosensing platform capable of quantifiable ultrasensitive analyte detection in a point-of-care format.

This presentation will discuss all the challenges and fundamentall advances made to date, including electrode integration, electrochemical optimization, and the resulting increases in sensor performance, using IgG as a model analyte.

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Topics

Point-of-care

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POSTER

5th European Biosensor Symposium

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Abstract Title:

From Thermal Precision to Thermal Freedom: Rethinking Nucleic Acid-Based Diagnostics

Abstract body:

Abstract

Temperature control is a critical factor in nucleic acid-based point-of-care (POC) molecular diagnostics. Polymerase chain reaction (PCR), the gold standard, requires three precise thermal steps in its cycle, and isothermal methods also depend on stable, accurate, constant heat conditions. This reliance on strict thermal regulation has confined amplification to instruments and controlled environments. But what if amplification no longer required such precise thermal control? We present an alternative approach that achieves robust amplification under simple, non-stringent temperature conditions, eliminating the need for strict stability. This paradigm shift enables nucleic acid-based diagnostics to move beyond laboratories, paving the way for truly decentralized applications such as resource-limited settings, outbreak response, and home testing.

Keywords: Temperature control, Nucleic acid amplification, point-of-care, diagnostic

Abstract References

None

Topics

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Abstract Title:

Handheld Dual-Mode Optical Detection Device for Pesticide Residue Monitoring in Food

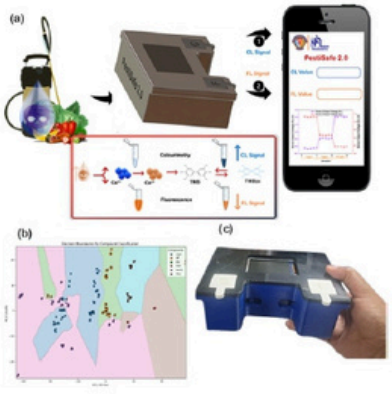
Abstract body:

Pesticide residues on food products pose significant risks to public health and the environment, as these chemicals can remain on the surfaces of fruits, vegetables, and other crops long after they have been applied[1]. Optical methods, particularly fluorescence-based techniques, provide a robust foundation for the detection of pesticide residues due to their high sensitivity, specificity, and suitability for field use. However, traditional systems often rely on a single read-out signal, which can result in challenges such as false positives and a low signal-to-noise ratio, ultimately undermining their reliability in variable field conditions[2]. To mitigate these issues, a multi-signal detection module is proposed. By utilising different signals for self-validation and self-correction, the accuracy of pesticide detection can be significantly enhanced[3]. This dual-modality device combines the benefits of colourimetric and fluorescence techniques, creating a comprehensive and user-friendly solution for detecting pesticide residues.

This work introduces a dual-mode optical detection system for pesticide residues that integrates colourimetric and fluorescence responses from cerium-based ions. This device serves as a viable option for pesticide residue detection in resource-constrained environments, as it also features an optoelectronic circuit with signal conditioning integrated into the detection module. This circuit effectively facilitates the integration, amplification, and filtering of both fluorescence and colourimetric signals without the need for any peripheral equipment.

The device was validated using both systemic and non-systemic pesticides and demonstrated commendable sensitivity, repeatability with deviation less than 5%, recovery rate, and linearity (1 ppb to 1 ppm for Imidacloprid) when compared to conventional detection systems. The Limit of Detection (LoD) for the developed system was 0.2 ppm for Malathion and 0.01 ppm for Imidacloprid, well below the maximum residual limit (MRL) established by the FAO. Consequently, the creation of this compact, 3D-printed dual-

mode integrated device can significantly enhance the rapid detection of pesticides in food quality assessments.



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Topics

Point-of-care

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POSTER

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Abstract Title:

Harnessing Nanobodies Towards Point-of-Care Trypanosomiasis Detection via Photoelectrochemical Sensing

Abstract body:

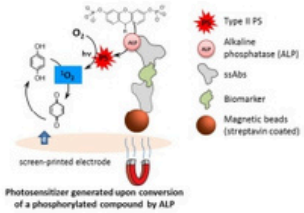
Animal African trypanosomiasis poses a severe threat to livestock health, placing over 50 million animals at risk and causing up to 3 million cattle deaths each year in Sub-Saharan Africa. Accurate diagnosis is essential for disease control but is hindered by antibody-based tests that cannot distinguish active from past infections. T. congolense pyruvate kinase (TcoPYK) has emerged as a promising biomarker of active infection, yet reliable detection tools are lacking.[1] To address this, we selected two nanobodies with high specificity for TcoPYK and developed a novel photoelectrochemical (PEC) platform enabling rapid and sensitive singlet oxygen ($^1O_2$)-based detection.

The assay uses nanobodies fused to alkaline phosphatase (ALP) to detect TcoPYK. Upon target binding, ALP converts fluorescein diphosphate into fluorescein, a type II photosensitizer. Under light illumination, fluorescein generates $^1O_2$, which reacts with the redox mediator to produce an amplified photocurrent, enabling rapid and sensitive PEC-based biomarker detection.[2]

Enzymatic dephosphorylation of fluorescein diphosphate by ALP yielded active fluorescein, which generated optimal $^1O_2$ and measurable photocurrent under 470 nm and 45 mW of light illumination. Only the product fluorescein produced a measurable signal, allowing clear discrimination from the inactive precursor which corresponds to the presence of TcoPYK and thus an active infection. A consistent photocurrent response was observed at 100 ng/mL ALP confirming sensitivity at low ALP concentration. Fusion constructs of nanobodies with ALP retained both enzymatic activity and target recognition, confirming their functional integrity in the assay format.

This study demonstrates the feasibility of a $^1O_2$-based PEC biosensor using nanobody–enzyme fusion constructs. The assay enables clear signal discrimination and maintains target recognition and enzymatic

activity, supporting its further development as a portable, sensitive diagnostic tool for detecting active African animal trypanosomiasis infections.



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Topics

Point-of-care

Wijten, Andy[1]; Toyos Rodríguez, Celia[1]; De Vocht, Line[2]; Smiejkowska, Natalia[2]; Sim, Yani[2]; Magez, Stefan[3]; Sterckx, Yann[2]; De Wael, Karolien[1]

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Harnessing optogenetic switches for innovative light-driven bioassays

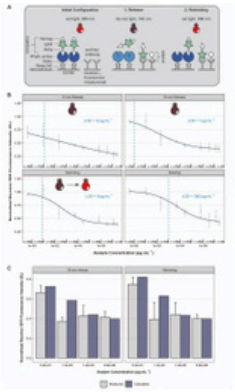
Abstract body:

Point-of-care (POC) devices, enabling quick and reliable on-site analysis, are not only advantageous in a temporal aspect, they are also important in resource-limited areas, where lab-based diagnostics is scarce, by allowing non-trained personnel or even the patients themselves to carry out medical tests.

In this regard, paper-based devices, widely used because of their low price-tag, share one common feature of a uni-directional sample flow without any external fluidic control. This, however, limits their flexibility in assay design and sample processing fundamentally. To circumvent this restraint, a standard competitive immunoassay was extended with light-controlled and reversible binding properties by utilizing the plant photoreceptor phytochrome B (PhyB) and its interaction partner phytochrome interacting factor 6 (PIF6). Through the far-red light induced dissociation at 740 nm and red light induced association at 660 nm, a bi-directional movement (i.e., release and rebinding) of the assay components is enabled, introducing the first light-controlled bioassay: the OptoAssay.

A proof-of-concept assay was implemented by using an His-tag as the analyte. This analyte competes with a is-tag-PIF6 complex released from PhyB in a wavelength-dependent manner for binding to a specific anti-His antibody (Figure 1A). We successfully demonstrated the functionality of the OptoAssay by performing a calibration. The achieved limit of detection of 8 pg mL–1 and an operation time of about an hour, the OptoAssay outperforms conventional ELISA assays (Figure 1B). Additionally, we validated the established model through spike-and-recovery experiments which showed a high accuracy, especially in at very low and high concentrations (Figure 1C).

The OptoAssay provides the fundamentals for a novel and dynamic assay format that could be integrated in various already existing POC systems, such as lateral flow assays, or pave the way for new classes of diagnostic devices in future obviating the need for external flow control systems such as pumps or valves.



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Topics

Point-of-care

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

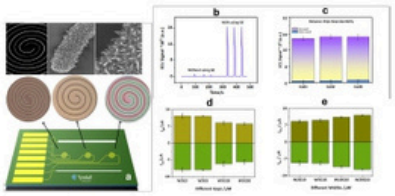
Highly Efficient Coreactant-Free Electrochemiluminescence Sensing Platform with Multiplexed Interdigitated Spiral Microelectrodes

Abstract body:

Traditional luminol-based electrochemiluminescence (ECL) systems rely on H_2O_2 as a coreactant, which limits their suitability for portable, on-site detection due to H_2O_2's instability [1-4]. We report a fully integrated, miniaturized ECL platform that eliminates the need for H_2O_2 by leveraging an interdigitated generator-collector electrode (GE&CE) design(**Fig1.a**). This system enhances reactive oxygen species (ROSs) generation under neutral pH, enabling stable, coreactant-free ECL detection. Through microfabrication [5-7], we achieved a compact, reproducible sensing chip with multiplexing capability, offering a promising solution for ECL-based point-of-care diagnostics.

we studied the electrochemical and ECL behaviour of seven microelectrode designs with varying gaps and widths as well as affecting parameters such as potentials, luminol concentrations, and oxygen conditions. Applying a -0.6 V bias to the GE enhanced the ECL signal 11-fold compared to the CE-only operation (**Fig1.b**). Narrower electrode gaps significantly improved the luminol ECL response, with the W2G2 design yielding the strongest signal. A 2.5-fold enhancement was also observed with a CE potential sweep but was less effective than the constant GE bias. The platform exhibited excellent signal reproducibility across nine sensors on three devices. Coreactant-free luminol ECL performance matched that of luminol-H_2O_2 systems (500 µM H_2O_2), confirming ROSs as effective alternative reactants. Trolox antioxidant and hydrogen peroxide detection using the W2G2 device demonstrated strong sensitivity and stability, validating the platform's utility in sensing. The W2G10-based biosensor, functionalized with a chitosan-gold nanocomposite and anti-IgG antibodies on the CE, exhibited excellent sensitivity for IgG detection, with a dynamic range from 1 fg mL^{-1} to 100 pg mL^{-1} with good performance in 25% FBS sample.

This coreactant-free, miniaturized ECL platform offers high sensitivity, multiplexing capability, and reproducibility, making it ideal for portable biosensing. Its integration with microfabrication technology opens pathways for real-time, multi-analyte point-of-care diagnostics without the limitations of H_2O_2-based systems.



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Topics

Point-of-care

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5th European Biosensor Symposium

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Abstract Title:

Highly sensitive Drug Detector based on a saliva biosensor for benzodiazepine detection

Abstract body:

Saliva samples are rapidly growing as valuable diagnostic tools in modern diagnosis and healthcare, due to the ability to reflect the body's overall health in a non-invasive way. Despite the complexity of saliva fluid, the advances in microfluidics, biosensors and lab-on-a-chip technologies are enabling the development of highly sensitive and specific saliva-based Point-of-Care (POC).

Herein, we present our work on the development of a novel and highly sensitive saliva-based POC. This device is capable of immediate analysis of saliva samples, providing an easy and non-invasive method that reflects the bloodstream drug levels.

The Drug Detector comprises of a multidisciplinary integration of components: the fluorescence reader and the lateral flow-based biosensor to detect the presence of drug in saliva samples.

- The biosensing technology is implemented on nitrocellulose paper placed within a microfluidic chip, featuring fluorescence optical detection. It is capable of detecting small molecules such as drugs through a competitive immunoassay. The technique achieves a semi-quantitative detection with very low detection limits (ng/mL) by employing a fluorescent lateral flow test, where antibodies are labelled with Quantum Dots.
- The fluorescence reader includes the necessary hardware and software to interpret the results. It incorporates algorithms and artificial intelligence code to analyse the presence of drugs in samples through mask readout and image processing. All these components are integrated into a portable and ergonomic design for testing drug in saliva samples. Moreover, the reader can be adapted to detect any analyte of interest that is compatible with fluorescent lateral flow assay.

Therefore, this project demonstrated that saliva can be considered a powerful biofluid for non-invasive diagnostic applications, such as drug of abuse testing. We believe saliva samples are shaping the future of easy, personalized, and accessible diagnostics and our device aims to be one of the tools used to analyse this important biological matrix.

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Topics

Point-of-care

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FLASH PRESENTATION

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Abstract Title:

Implantable Multiparametric Sensing Device for Point-of-Care Cardiovascular Biomarker Detection

Abstract body:

Heart failure (HF) has been defined as a global pandemic, with 64.3 million people estimated to suffer from it worldwide in 2017 [1]. These figures, however, do not account for the vast number of patients who remain undiagnosed or are misdiagnosed, often due to the absence of continuous, personalized monitoring systems. Therefore, a point-of-care system capable of providing both patients and clinicians with relevant and accurate data on disease progression and severity could greatly enhance clinical decision-making and patient outcomes.

This research is framed within the European IV-Lab project, which aims to develop an implantable multiparametric biosensing device. The system integrates electrochemical sensors capable of detecting both key electrolytes (K^+, H^+) and gold standard cardiac biomarkers (BNP, NT-proBNP) directly from blood samples, enabling real-time and in situ health monitoring.

The potassium and hydrogen sensors were optimized using commercial carbon and gold electrodes, respectively, achieving high sensitivities above 95 mV/mM for K^+ and 90 mV/pH for H^+. To extend sensor lifespan and reduce biofouling, a hydrogel coating was applied to the potassium sensor membrane in collaboration with IBEC. Contact angle analysis and SPR confirmed successful deposition, with hydrophilicity increasing (90° to 40°) and an additional ~15 nm layer corresponding to the hydrogel observed. For BNP detection, an aptabeacon (APTB) was designed and immobilized on gold electrodes using thiol chemistry and mercaptohexanol spacers. Its structural folding and redox-active distance were optimized in silico. A combined SPR–potentiostat platform allows simultaneous kinetic and electrochemical measurements of APTB-BNP interactions in real time.

These results validate the feasibility of integrating electrochemical and optical techniques into a robust implantable platform for precision cardiovascular monitoring. Next, antifouling properties will be evaluated in

real time using SPR with BSA exposure for 24 hours, followed by electrochemical measurements to assess potential signal degradation.

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Topics

Point-of-care

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Abstract Title:

Innovative Gold Nanoparticle Conjugates as a Key to Ultrasensitive Lateral Flow Assays

Abstract body:

Medical diagnostics plays a fundamental role in healthcare, enabling the identification of diseases and the implementation of appropriate treatments. The modern and future world is unimaginable without the ability to detect a wide range of pathogens. This field is continuously evolving, and the improvement of tools used within it attracts considerable attention from both the scientific community and industry.

The global scope of the COVID-19 pandemic has highlighted the critical importance of diagnostic tests characterized by rapid detection time, specificity, and sensitivity [1]. These criteria are met by immunochromatographic lateral flow assays (LFA). Their major advantages include the ability to provide results within a short time frame, without the need for expensive instrumentation or highly trained personnel. These features make LFA a promising tool for antigen detection in low-resource settings, where infectious diseases remain a significant threat. Moreover, they can also play a crucial role in the diagnosis of cancer [2], which is among the leading health challenges in developed countries.

Despite their many advantages, commercially available LFAs still require improvements, particularly in terms of sensitivity, to enhance the reliability of results. Several parameters can be optimized to achieve this goal [3]. One of which is the modification of the reporters used in the assay. In my studies, I employed gold nanoparticles conjugated with antibodies targeting specific antigens as reporters. I analysed the impact of various factors, such as size and morphology, on the detection limit of self-constructed diagnostic tests. Our innovative approach has the potential to revolutionize analyte detection in medical diagnostics.

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Topics

Point-of-care

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FLASH PRESENTATION

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Abstract Title:

Label-Free Detection of Cardiac Biomarkers Using NanoMIPs-Functionalized Conductometric Sensors

Abstract body:

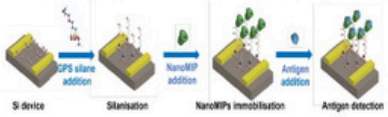
Background: Cardiovascular diseases (CVDs) are a major global health issue, greatly affecting patient mortality. Early detection through cardiovascular biomarkers is essential for quick intervention. However, traditional diagnostic methods often use large, expensive instruments and centralized labs, which can delay results. As a solution, there is an increasing interest in developing low-cost, portable biosensors that enable rapid testing at the point of care. These devices can provide quick insights into a patient's heart health, improving disease management. This study introduces new biosensing method using artificial receptors to detect three important cardiac biomarkers: BNP, NT-proBNP, and cTnI from saliva samples.

Materials & Methods: Conductometric sensors with gold-patterned electrodes on high-resistivity silicon were functionalized with (3-glycidyloxypropyl) trimethoxy silane (GPS) and immobilized with cardiac-specific molecularly imprinted polymer nanoparticles (nanoMIPs). Biomarker detection was performed in diluted PBS and artificial saliva (pH 7.4), with 10-minute incubation and resistance measurements captured within 3 minutes.

Results: The nanoMIPs-functionalized conductometric sensors demonstrated high sensitivity and selectivity for BNP, NT-proBNP, and cTnI, with significant resistance changes observed upon biomarker binding. The sensors exhibited rapid detection within 3 minutes and operated effectively in both PBS and artificial saliva. The orientation and binding efficiency of nanoMIPs improved

with GPS treatment, leading to consistent and reliable signal outputs. Importantly, the biosensors could be reused for at least two cycles without significant performance loss. These findings suggest strong potential for non-invasive, real-time detection of cardiac biomarkers using human saliva samples.

Conclusion: This study introduces a promising conductometric biosensing platform for quick, non-invasive, label-free detection of cardiac biomarkers. The nanoMIPs-functionalized sensors provide a cost-effective and reusable method, suitable for point-of-care diagnostics. This advancement has the potential to transform how we monitor heart health, enabling earlier detection and supporting better clinical decisions.



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Topics

Point-of-care

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Label-Free Optical Biosensor with SAW-Based Micromixing for Sensitive Lactoferrin Detection

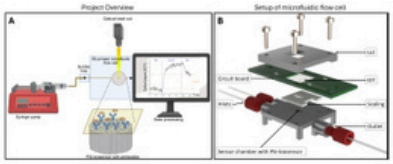
Abstract body:

In recent years, interest in lactoferrin (LF) has grown significantly. Emerging studies suggest that this iron-binding glycoprotein may serve as a promising biomarker for the early diagnosis of various diseases – including inflammatory bowel disease, Alzheimer's disease, and dry eye disease [1]. Conventional methods for detecting LF rely on immunoassays such as ELISA or instrumental analysis via reversed-phase high-performance liquid chromatography (RP-HPLC) [2], both of which are labour-, cost-, and time-intensive.

Therefore, the aim of this project is to develop an optical, label-free, biosensor integrated into a 3D-printed microfluidic flow cell for the detection of LF (see Figure 1 A). Porous silicon (PSi), produced via electrochemical etching, is employed as the transducing material. Antibodies immobilized on the PSi surface serve as specific capture elements for LF detection. The microfluidic flow cell is fabricated using high-resolution 3D printing and incorporates an active surface acoustic wave (SAW)-based micromixer to enhance fluid mixing within the sensor chamber (see Figure 1 B).

Successful biosensor fabrication was confirmed using scanning electron microscopy (SEM) and Fourier-transform infrared spectroscopy (FTIR). Biosensing experiments were performed via reflective interferometric Fourier transform spectroscopy (RIFTS), demonstrating LF detection in phosphate-buffered saline (PBS) at concentrations as low as 0.5 µM. To address mass transfer limitations that reduce the sensitivity of PSi-based biosensors [3], the integrated SAW micromixer was employed to enable for continuous mixing inside the sensor chamber. This approach significantly enhanced mass transfer into the porous silicon nanostructure, thereby improving sensor sensitivity.

The advantages of this sensor platform include high specificity through the PSi-based biosensor, relatively low fabrication cost, and improved performance achieved by acoustofluidic mixing. These features position the system as a promising advancement for point-of-care diagnostics in biomarker detection.



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Topics

Point-of-care

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Abstract Title:

Malaria diagnosis and prognosis with an electrokinetic-driven aptamer-based lateral flow assay (MalDiProT).

Abstract body:

Malaria remains a public health concern, with 247 million cases and 619,000 deaths reported globally in 2021 [1]. Implementing large-scale, high-coverage, early diagnosis, and accurate prognosis of severe malaria is critical to reducing the impact of malaria in Europe. Due to its high sensitivity, parasite counting by microscopy observation is the current gold standard method. However, it is inappropriate for its application at the point of care [2]. The rapid diagnostic tests based on lateral flow assay are the best option for PoC testing since they accomplish the REASSURED criteria WHO recommends. However, this method doesn't provide quantitative prognostic information and has proved low clinical sensitivity with low parasitemia samples [3-4]. To this end, the objective of the MalDiProT project is to develop for the first time a smartphone-powered electrophoretic-driven aptamer lateral flow assay capable of providing a quantitative measurement of 2 parasite (PfHRP2, pLDH) and 2 host (angiopoietin-1 and -2) malaria biomarkers within minutes. A 3D-printed electrophoretic device weighing 151 g and costing €82 in lab-scale manufacturing was developed. The device allows simultaneous analysis of three samples and operates with an energy consumption of only 225 mAh^1, offering up to 44 hours of operation with a single charge [5]. By optimizing key assay parameters such as Joule heating, electrophoresis buffer evaporation, and control over electroosmotic flow, the device enables iterative incubation and washing steps directly on the nitrocellulose strip, something unachievable with conventional LFIA based solely on capillarity. Besides, a DNA aptamer was identified for angiopoietin-1 using conventional magnetic beads-based SELEX, with a dissociation constant of 186 pM. The work in progress is to identify DNA aptamers for the other malaria biomarkers and integrate them into the electrophoretic-driven lateral flow assay. Upon successfully validating the device in non-endemic areas, I expect its use in low-resource, malaria-endemic areas.

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Topics

Point-of-care

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Minimalistic electronics and fit-to-purpose batteries for responsible point-of-care diagnostics

Abstract body:

The global point-of-care (PoC) diagnostics market continues to grow steadily, driven by rising infectious diseases, cancer cases, and a shift toward preventive medicine. To meet the increasing global demand, testing capacity must go beyond current standard approaches. The REASSURED framework outlines key criteria for effective PoC testing: Real-time connectivity, Environmentally Friendly, Affordable, Sensitive, Specific, User-Friendly, Rapid, Equipment-free, and Delivered where needed.[1]

Molecular diagnostics enable rapid and accurate detection of biomarkers at the patient's side. The COVID-19 pandemic highlighted the need for tests with PCR-level performance, prompting the development of new devices. However, many were complex, costly, and environmentally unsustainable, leading to their market withdrawal. This emphasized the need to design PoC technologies with economic and environmental sustainability throughout their lifecycle.[2]

Our approach focuses on creating minimalistic electronic devices powered by fit-for-purpose energy sources.[3] We present a paper-based, liquid-activated battery in a lateral flow format, compatible with existing rapid test manufacturing processes. These batteries can power key features in portable diagnostic tools—such as sensors, displays, wireless communication, or heating.

We demonstrate their application in a fast, low-cost isothermal amplification module driven by a minimal electronic circuit. Validated in a clinical setting, this prototype offers a practical alternative to conventional molecular PoC devices by addressing cost and environmental limitations.

This presentation will include an overview of the learnings gathered over the last decade from interactions with industry, as well as an outlook towards the generation of portable healthcare technology that meet

performance and economic requirements while considering the relationships between biophysical resource use and social outcomes.

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Topics

Point-of-care

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Abstract Title:

Multifunctional Edible Hydrogel for Glucose Sensing and Controlled Drug Release in GI-Tract

Abstract body:

Edible biosensors represent a cutting-edge solution for real-time, non-invasive monitoring of biochemical markers—such as glucose, hormones, enzymes, and pharmaceuticals—facilitating advances in remote diagnostics and personalized medicine. However, challenges remain in developing ingestible, biocompatible materials that comply with FDA and EFSA guidelines while maintaining functional stability in the gastrointestinal (GI) tract, which is characterized by low pH, elevated temperatures, and complex, fouling-prone fluids.

To address these limitations, a multifunctional edible hydrogel was engineered by incorporating polydopamine (PDA) into a sodium alginate–calcium chloride polymeric network. This formulation yielded a robust, self-supporting, conductive, and biocompatible matrix suitable for bioelectronic integration. The PDA-enhanced alginate hydrogel platform offers a promising route toward fully ingestible bioelectronic devices capable of in situ sensing and localized drug delivery within the GI tract.

Its multifunctionality was demonstrated by employing the hydrogel for oral drug delivery: a film was loaded with Bovine Serum Albumin (BSA) as a model cargo and rhodamine as a fluorescent tracer to monitor release kinetics. While for glucose-sensing applications, silver nanoparticles (AgNPs) were embedded within the hydrogel to enhance the stabilization of glucose oxidase (GOx), improving enzymatic activity and sensor performance.

Electrochemical characterization, including cyclic voltammetry and impedance spectroscopy, confirmed favorable electron transfer kinetics, increased electroactive surface area, and reduced interfacial resistance. Scanning Electron Microscopy (SEM) revealed uniform nanoparticle distribution and structural integrity. Mechanical stability under physiologically relevant conditions was validated via dynamic mechanical analysis.

MTT cytotoxicity assays on Caco-2 and HTB-37 intestinal cell lines demonstrated high biocompatibility, confirming the material's safety for ingestion.

An edible film platform offers distinct advantages—such as patient compliance, safe degradation, and multifunctional performance—making it highly suitable for combined diagnostic and therapeutic use.

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Acknowledgment We acknowledge financial support under the National Recovery and Resilience Plan (NRRP), Mission 4, Component 2, Investment 1.1, Call for tender No. 1409 published on 14.9.2022 by the Italian Ministry of University and Research (MUR), funded by the European Union – NextGenerationEU– Project "Title gReen analytical methods for PAHs detection in EVOO: from lABoratory to smart LabEl" (RELIABLE) – CUP H53D23007750001- Grant Assignment Decree No. 1386 adopted on 01/09/2023 by the Italian Ministry of Ministry of University and Research (MUR).

Topics

Point-of-care

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5th European Biosensor Symposium

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Abstract Title:

Multiplexed biomarker detection with an electrochemical in-vitro point-of-care device

Abstract body:

Background: Conventional analysis of disease biomarkers, performed in clinical laboratory settings, are usually laborious, time consuming and should be carried out by trained professionals. By contrast, point-of-care testing devices are simple, easy to use, inexpensive and can deliver real-time analytical information to aid in the rapid diagnosis of a disease, being especially useful in developing countries with limited resources. Here, we report on the development of a fully functional handheld analytical tool comprising an integrated electrochemical point-of-care prototype that enabled the simultaneous measurement of up to five biomarkers in a biological sample.

Materials & methods: The prototype comprises three components: a reusable array of five individually addressable gold two-electrode electrochemical cells; a disposable fluidic component that includes five nitrocellulose paper channels; and a compact device housing, which can be easily assembled and disassembled after one analysis. The device prototype was designed following the requirements of a medical tool for in-vitro diagnostics, and complying with the ISO13485 quality standard. Integrated low-power electronics was also designed and manufactured. The device was battery-powered when connected to a mobile phone where a custom-made app was installed for device control and data management.

Results: Electrochemical measurements performed in standard solutions of a representative redox species showed an excellent reproducibility of 4.4% RSD among the five channels. A response variation between 0.9 % and 4.0% was observed in the calibration curves comparing to those recorded using commercial electronics. In order to show the overall device potential as a diagnostic tool, the detection of lactate dehydrogenase enzyme activity in serum was carried out. The prototype was designed to be easily coupled to different biological reactions and thus adapted and applied to the measurement of a variety of disease-related biomarkers.

Acknowledgements: The work has received funding from "la Caixa" Foundation under the project code HR23-00679.

Abstract References

Topics

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Abstract Title:

Multiplexing amplification and detection biosensor design using LAMP-based nucleic acid amplification for viral infection targets followed by readout via lateral flow assay

Abstract body:

LAMP-based isothermal nucleic acid amplification has been an established method since *2000* but became popular since the growth in demand for PCR alternatives during the COVID-19 pandemic. The **advantages of LAMP** have helped overcome POC limitations with the gold-standard PCR method: *reduction in amplification time due to robust enzyme activity, omission of the need for thermal cycling due to being isothermal, simple transfer to different POC-applicable readout possibilities, and lastly, flexibility to use complex sample matrix directly for amplification*.

During the pandemic, most research applications using LAMP were concentrated on SARS-COV-2 detection. Here we present ***the diagnosis of the dengue virus (RNA virus) and its 4 subtypes*** using LAMP amplification and subsequent LFA readout. The RNA of the dengue virus was extracted from real-patient samples, tested positive for the dengue virus by PCR. The LAMP reaction mixture was adapted from Agarwal et al. (2023), with amplification performed at *65 degrees for 25 min.*, followed by dipping the LFA strip into the reaction solution for the readout. The designed dengue virus LAMP-based detection was successfully amplified, and the readout of amplicon from each subtype was positively read out via the 1T-LFA. Further, the work was improved to create duplex-LAMP for 2 subtypes of dengue virus types in one pot. This is also shown to be successful and supported by duplex readout via the 2T-LFA.

The results promisingly show the *synergistic effect* of LAMP and LFA-based biosensors can be a new, rapid, cost-effective, low-maintenance, POC-applicable analytical technique to detect the dengue virus in human samples. Such an idea supports POC application of the biosensor setup along with supporting *collection of epidemiological information for surveillance and monitoring of the epidemic and pandemic potential of the*

infection. Future work is focused on improvements in assay parameters for on-field validation of the biosensor and prototyping.

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Topics

Point-of-care

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Abstract Title:

Nanochannels technology for single-molecule tracking and identification of biomarkers related to Age-related Macular Degeneration

Abstract body:

Abstract

Proteins' identification and quantification remain a technological challenge due to their complexity, variety and low-abundance in biological samples. Single-molecule technologies based on nanofluidics are emerging as powerful diagnostic tools with unprecedented sensitivity for molecules detection and fingerprinting[1,2,3]. Recently, we developed a technique to deliver proteins through T-shaped nanochannels filled with polymer gels. By tuning the device's electrokinetic properties, we track protein migration within the channel using a custom-built single-molecule fluorescence imaging system[4]. This method is a powerful tool for single-molecule protein sensing, which can be used to discriminate several panels of biomarkers and proteins isoforms, and is compatible with liquid biopsy since few picoliters are required for the analysis.

Materials & Methods

Thin nanochannels are fabricated on silicon substrates by UV lithography (Figure 1a). The device is mounted on the single-molecule fluorescence imaging setup where two lasers are alternated on the chip while the fluorescence emitted by the labelled proteins is collected with a high NA objective and imaged with an EM-CCD camera.

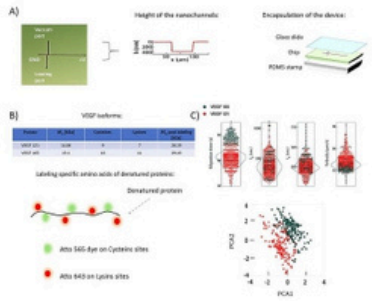
Results

We use this device for the identification and quantification of a panel of biomarkers related to the Age-related Macular Degeneration (AMD) disease, including VEGF isoforms, CCl2, RBP4, Clusterin and Serpin A4, which

have been selectively labelled with green and red dyes on their C and K residues (Figure1b). After loading the proteins in the device, we image their migration through electrophoresis and track them individually to extract physical parameters related to their motion, as well as their green, red and FRET intensities. These features are then used for the identification of the biomarkers in each sample (Figure1c).

Conclusions

Our nanochannel-based technology can track and identify biomarkers related to AMD in low concentrations and ultra-low volumes. This method enables the identification of protein panels for early stage diagnostics and diseases monitoring from different body fluids.



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Point-of-care

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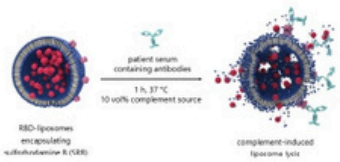
Abstract Title:

New Point-of-care Compatible Technology for Antibody Detection Using Fluorescent Liposomes

Abstract body:

Rapid and decentralized monitoring of antibodies in patient serum allows statements about a current infection or an individual's immunity against an infection and is therefore an important part of pandemic preparedness. A liposome-based diagnostic assay compatible for point-of-care readout was developed that detects and quantifies anti-SARS-CoV-2 antibodies. Liposomes serve as mimics of biological membranes [1] and are designed to quantitatively release a self-quenching fluorophore (sulforhodamine B) upon complement-induced liposome lysis. Complement activation is triggered by antibody binding to the antigen-decorated liposomal surface [2], using the receptor binding domain (RBD) of SARS-CoV-2 as model detection element. The system was optimized for best signal-to-noise ratios, rapid and simple responses through studies of lipid composition, size, surface chemistry and incubation times. The assay principle could be demonstrated using a commercial anti-RBD antibody and commercial human serum. Serological testing of patient samples resulted in high sensitivity (93 %) and specificity (95 %). Its homogeneous, wash-free format enables rapid signal development and minimizes handling steps, making the assay well-suited for adaptation to a lateral flow assay format by capturing intact liposomes on a test line and separating them from lysed ones. By a simple optical or fluorescence determination, a qualitative or even semi-quantitative readout is possible. As it can be easily adapted for other viral targets by changing the surface antigen, our liposome platform provides



a new avenue for decentralized immunodiagnostics.

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Topics

Point-of-care

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ORAL COMMUNICATION

5th European Biosensor Symposium

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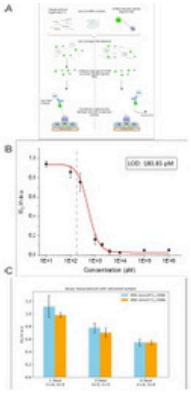
On-site CMV diagnostics using a CRISPR-powered microfluidic biosensor

Abstract body:

Despite decades of research efforts, cytomegalovirus (CMV) continues to present significant risks to neonatal health and immunocompromised patients. The congenital CMV infection is recognized as one of the most prevalent non-genetic causes of congenital hearing loss, emphasizing the need for early and accurate diagnosis to prevent severe complications. Traditional diagnostic methods, like qPCR, are often resource-intensive and complex, highlighting the need for cost-effective and rapid alternatives. With their efficient point-of-care capabilities, the microfluidic biosensing platforms offer a promising solution for the detection of CMV infection. This study presents a novel CRISPR/Cas12a assay (Figure A) integrated into an electrochemical microfluidic biosensor for a nucleic-acid-amplification-free CMV diagnosis. This method offers high specificity and uses low-cost polymers through dry-film photoresist technology, offering a facile and high-throughput sensor production. After optimizing the time, enzyme and reagent concentrations, our system demonstrated a sensitivity of 180.85 pM (~1.1 × 10^8 copies ml–1) with AsCas12a Ultra enzyme (Figure B), a highly active Cas12a nuclease. The system was evaluated using extracted CMV DNA of urine samples from CMV infected newborns with a turnaround time of about five hours (Figure C). Overall, the developed biosensor offers significant advantages in terms of time efficiency, cost reduction, and ease of use compared to standard qPCR for congenital CMV infection. Its ability to detect target concentrations down to the picomolar range without target amplification highlights its potential to be a powerful point-of-care diagnostic tool for CMV detection.



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Topics

Point-of-care

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Optimisation of Interdigitated Electrode (IDE) Conductometric Biosensors for Cardiac Troponin I Detection

Abstract body:

Background: Conductometric biosensors detect changes in electrical resistance caused by interactions at the sensor surface, offering a label-free and cost-effective approach for biomarker detection. Interdigitated electrodes (IDEs) are widely used in these sensors due to their simple design and high sensitivity. This study focuses on the design, fabrication, and optimisation of IDE sensors for the detection of cardiac troponin I (cTnI), a key biomarker for myocardial infarction. The performance of IDEs with varying electrode pairs (1, 2, 4, 8, 16, and 32) was evaluated in PBS, artificial saliva, and pooled human saliva to identify the most effective configuration.

Materials & Methods: High-resistivity silicon-based IDE sensors with varying electrode pairs (1–32) were fabricated and functionalized with molecularly imprinted polymers (nanoMIPs) specific to cTnI. Electrical resistance was recorded after sample application in PBS, artificial saliva, and human saliva matrices.

Results: IDE sensors functionalised with nanoMIPs showed concentration-dependent resistance changes upon exposure to cTnI across all test media. Minimal or negative responses were recorded with interfering biomarkers, confirming good specificity. Among the tested configurations, 8- and 16-pair sensors offered optimal sensitivity and signal stability in PBS and artificial saliva. The 16-pair sensor performed best in human saliva, showing clear signal separation at femtomolar concentrations. Results demonstrate consistent and reproducible performance, with a strong correlation between cTnI concentration and resistance change, making it suitable for point-of-care use.

Conclusion: The 16-pair IDE sensor exhibited good sensitivity, selectivity, and stability for detecting cTnI, even in complex media like human saliva. These results support the potential of IDE-based conductometric biosensors as effective, non-invasive tools for early cardiac biomarker detection at the point of care.

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Topics

Point-of-care

Chidambaram, Preethi[1]; Dhanabalan, Shanmuga Sundar[2]; Ako, Rajour Tanyi[1]; S P, Sreekanth[1]; S Perera, Ganganath[1]; Akhlaghi, Fateme[1]; Bhaskaran, Madhu[1]; Sriram, Sharath[1]
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POSTER

5th European Biosensor Symposium

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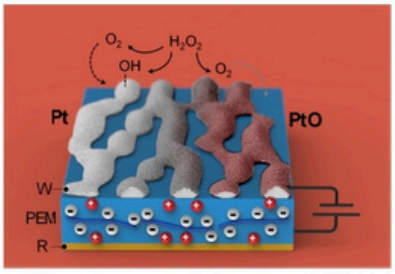
Abstract Title:

Paper-Based Semi-Open Electrochemical Cells: A Scalable Platform for Non-Invasive Lactate Biosensing

Abstract body:

Lactate is a critical biomarker in sports physiology that indicates metabolic changes during exercise and informs performance optimization strategies. Current monitoring approaches require invasive blood sampling, which limits real-time and field-based applications [1]. We developed a non-invasive lactate biosensor for analyzing minimal sweat volumes using a novel vertical stack electrode configuration—a semi-open electrochemical cell (SOEC) [2]. However, manual assembly methods present significant reproducibility and scalability challenges. To overcome this limitation, we propose a scalable manufacturing process utilizing screen-printing and straightforward casting techniques with paper substrates. Our research investigates the optimization of proton exchange membranes and electroactive materials to enhance analytical response. We also characterized the system against laboratory-scale benchmarks to validate our approach. This integrated solution provides an accessible platform for sweat-based lactate monitoring, combining the manufacturing benefits of the electrochemical cell design with practical requirements for non-invasive biomarker detection, enabling broader deployment in athletic and clinical applications.



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Topics

Point-of-care

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Abstract Title:

Photoelectrochemical Detection of FLT3 Mutations in Acute myeloid Leukaemia (AML) Validated on Clinical Samples

Abstract body:

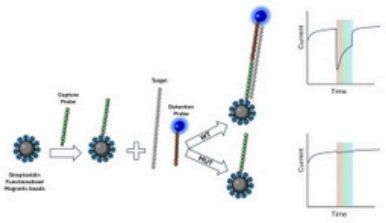
Acute Myeloid Leukaemia (AML) is a heterogeneous haematological malignancy in which mutations in the FLT3 gene, particularly internal tandem duplications (FLT3-ITD) and point mutations in the tyrosine kinase domain (FLT3-TKD), are strongly associated with poor prognosis and therapy resistance. The detection of these mutations is essential for patient stratification and treatment guidance. Polymerase-chain reaction (PCR) and next-generation sequencing (NGS) are the current gold-standards for mutation detection, but these techniques are time-consuming, costly, and equipment-dependent, limiting their accessibility1.

Here, we present a photoelectrochemical (PEC) assay that employs a sandwich design integrating two complementary oligonucleotide probes: a biotin-labelled capture probe for target DNA immobilization and a detection probe labelled with a photosensitizer for signal generation. Upon hybridization with the target DNA, the photosensitizer is activated under light irradiation to produce singlet oxygen ($^1O_2$), resulting in a quantifiable photocurrent response. This dual-probe strategy ensures exceptional specificity, facilitating the reliable detection of mutation-bearing DNA in complex biological matrices2.

By tuning the hybridization temperature, we demonstrate an 88.8% signal difference between wild-type and mutated sequences, indicating high specificity and sensitivity. Crucially, the assay was applied to clinical samples obtained from both lumbar puncture and bone marrow aspirates. Genomic DNA was extracted and tested without prior amplification. The PEC results were validated by NGS, confirming the platform's clinical relevance and diagnostic accuracy.

This study represents the first clinical validation of a PEC biosensor for FLT3 mutation detection. With the combination of single-base discrimination, simplified temperature-tuned hybridization, and amplification-free

detection, fast molecular diagnostics in AML is possible using this platform, with an excellent possibility to be applied in point-of-care and resource-limited settings.



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Point-of-care

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Abstract Title:

Point-of-Care Electrochemical Biosensing Platform for Therapeutic Drug Monitoring in Precision Oncology

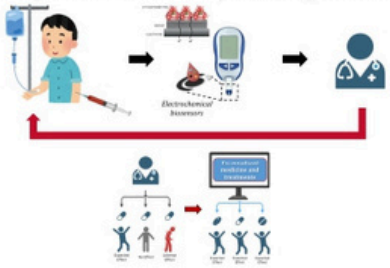
Abstract body:

Precision oncology necessitates accurate therapeutic drug monitoring (TDM) to personalize chemotherapy, ensuring treatment efficacy while minimizing toxicity. Widely used chemotherapeutic drugs like Cyclophosphamide, Etoposide, Ifosfamide, Methotrexate, and 5-Fluorouracil have narrow therapeutic windows and high inter-individual pharmacokinetic variability [1]. Current TDM methods, like chromatography-mass spectrometry, are effective but expensive, complex, and unsuitable for real-time, point-of-care (PoC) use. Electrochemical sensors offer an attractive alternative due to their low cost, rapid response, high sensitivity, and portability, making them ideal for integration into clinical practice for real-time dosage adjustment [1,2].

To address this clinical need, we developed a multi-drug electrochemical sensing platform using multi-walled carbon nanotubes to enhance electron transfer and cytochrome P450 enzymes to improve selectivity. Our biosensors successfully detect the five key chemotherapeutic agents, Cyclophosphamide, Etoposide, Ifosfamide, Methotrexate, and 5-Fluorouracil, both individually and in combination, enabling real-time TDM in a portable PoC device. The biosensors exhibit high sensitivity, with limits of detection ranging from 0.5-5 µM, all within clinically relevant therapeutic ranges, enabling precise monitoring in a PoC device. Furthermore, we simultaneously detected three out of five chemotherapeutic drugs (Etoposide, Methotrexate, 5-Fluorouracil) on a single electrochemical sensor, addressing a key clinical need, as standard chemotherapy protocols often involve the administration of drug cocktails.

In conclusion, this portable PoC electrochemical sensing platform enables rapid TDM of chemotherapeutic agents, supporting precision oncology. By combining sensitive, selective biosensors with potential machine learning integration [3], it provides oncologists with ready-to-use analytical tools for patient-specific dosage

adjustments, improving chemotherapy efficacy and safety through individualized treatment strategies.



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Topics

Point-of-care

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Abstract Title:

Point-of-Care Test for Pseudomonas aeruginosa Infections Targeting a Quorum Sensing-Regulated Virulence Factor

Abstract body:

Background

Point-of-care (POC) devices offer rapid, accurate diagnosis of infections near the patient care, enabling timely treatment and improved outcomes. Their speed and simplicity also support optimized antibiotic use, addressing the growing problem of antimicrobial resistance. *Pseudomonas aeruginosa* is a major opportunistic pathogen responsible for severe infections and was linked to an estimated 660,000 deaths in 2021. Early diagnosis is essential to prevent biofilm formation and disease progression. *P. aeruginosa*'s Quorum Sensing (QS) system regulates virulence factors and biofilms via small signalling molecules, making these attractive diagnostic biomarkers. This study reports the development of a Lateral-Flow Immunoassay (LFIA) to detect pyocyanin (PYO), a QS-regulated virulence factor specific to *P. aeruginosa*.

Methodology

A LFIA was developed using monoclonal antibodies (mAbs) raised against PYO and a BSA bioconjugate carrying a PYO hapten. The mAbs were biotinylated, and signal detection was achieved using anti-biotin antibodies labelled with gold nanopaticles. The test and control lines were printed with the PYO-BSA conjugate and anti-IgG antibodies, respectively. A mixture of labelled primary and secondary antibodies was deposited onto the sample pad. Upon sample application, PYO, if present, binds to the primary antibody and competes with the immobilized conjugate at the T-line. Non-invasive clinical samples such as sputum and oropharyngeal swabs were tested.

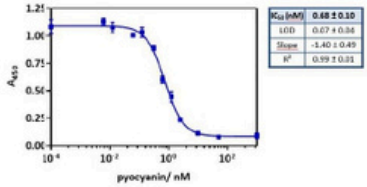
Results

A highly specific mAb (C.9.1.9.1.1.2.2) capable of detecting PYO at 0.07 nM was produced and used to

develop a sensitive microplate-based ELISA. The same immunoreagents were successfully integrated into the LFIA, demonstrating strong potential for rapid *P. aeruginosa* detection across various biosensor platforms.

Conclusion

The specific mAb for pyocyanin has enabled both the creation of a sensitive ELISA and the groundwork for a LFIA, which could represent a key advancement toward practical PoC diagnostics. This could enable early detection and monitoring, improving antimicrobial therapy and patient outcomes, particularly in immunocompromised populations.



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Topics

Point-of-care

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Abstract Title:

Portable PCR-Based Genosensing for Point-of-Care Detection of Neonatal Streptococcus agalactiae Infections

Abstract body:

Streptococcus agalactiae (Group B Streptococcus, GBS) is a leading cause of neonatal infections globally, associated with maternal sepsis, stillbirth, and both early- and late-onset neonatal sepsis. Up to 35% of pregnant women may be colonized, with a disproportionately high disease burden in low-resource settings. Current detection relies on culture-based methods that are time-consuming, require specialized infrastructure, and are impractical for rapid clinical use, particularly in newborns, where sample volumes are limited, and turnaround times are critical. This research presents the development of a portable, point-of-care screening platform combining a handheld thermocycler with an electrochemical genosensing system. The assay employs double-tagging endpoint PCR targeting a GBS-specific gene, using a thermostable DNA polymerase. Various bacterial lysis protocols were evaluated, along with the assay's specificity and analytical sensitivity. Importantly, the method has already been applied to the analysis of clinical vaginorectal swab samples, with successful detection of GBS-positive cases, supporting its potential for real-world application. Ongoing work includes expanding validation with different biological matrices (e.g., blood) and assessing the system's performance across broader clinical scenarios. The proposed platform offers a rapid, simple, and accurate alternative for GBS screening, with significant implications for improving maternal and neonatal outcomes—especially in settings where conventional microbiological methods are difficult to implement.

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Topics

Point-of-care

Pallarès Rusiñol, Arnau[1]; Del Valle, Anaixis[2]; Porras, Juan Carlos[1]; Mesas, Melania[1]; Martí, Mercè[2]; Baro, Bàrbara[3]; Ferrer-Dalmau, Jofre[1]; Bassat, Quique[3]; Pividori, Maria Isabel[2]

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Abstract Title:

PRINTED ELECTRONICS TECHNOLOGY AND LAB-ON-FOIL APPLICATION IN RAPID AND RELIABLE NUCLEIC ACIDS DETECTION

Abstract body:

Standard determination of pathogen susceptibility to antibiotics is usually time-consuming and fails to provide actionable data within clinically relevant timeframes. Electrochemical DNA biosensors pose an attractive alternative due to their high sensitivity, low energy consumption, and short response time [1]. The use of miniature electrodes in the sensing element allows for integration of the sensor into a microfluidic lab-on-foil system. This enables the production of portable and low-cost diagnostic devices. This approach reduces the required sample volume and shortens the analysis time, ensuring rapid transport of the analyte to the sensing element and minimising diffusion limitations [2, 3]. A key challenge is the quality and reproducibility of the transducer surface on which the bioreceptor is immobilised. Different deposition techniques allow for obtaining different surface properties (e.g.: roughness or uniformity of the layer). The optimisation of the production technique and the preparation of the gold electrode surface are essential to achieve uniform electron transfer kinetics and reliable sensor performance [4].

Presented research focuses on the feasibility of using planar, gold electrodes, obtained by physical vapour deposition (PVD) on a polymer surface in a miniature lab-on-foil system. The *vanB* gene, a determinant of bacterial vancomycin resistance, was chosen as the analytical model for detection. The detection mechanism was based on carefully designed DNA probes and complementary methylene blue-labelled samples, using electrochemical detection. The current response was generated only after the hybridisation reaction, which allows for selective gene detection. The designed system enables selective analyte detection using the detection mechanism under investigation, and its use results in more efficient mass exchange enabling higher current responses to be obtained in the microfluidic system compared to the steady-state studies.

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Topics

Point-of-care

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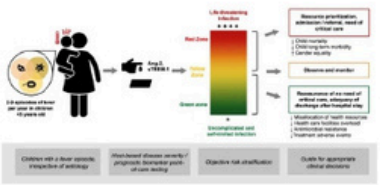
Abstract Title:

Rapid Stratification of Fever Syndromes using a Traffic Light-based biosensor for sTREM-1

Abstract body:

Recent evidence highlights the significance of the soluble fragment of the Triggering Receptor Expressed on Myeloid cells 1 (sTREM-1) as a novel quantitative biomarker for assessing disease severity, treatment response, and outcomes in fever syndromes. sTREM-1 has shown better prognostic performance than traditional predictors[1, 2, 3], with high levels strongly associated with disease severity, organ dysfunction, and mortality. To aid in risk stratification, patients in this study were classified into three groups based on their sTREM-1 levels using the WHO-proposed traffic light color system[4].



A threshold value of 239 pg/mL represented the "green light," indicating low risk according to uncomplicated and self-limited infections, while levels exceeding 629 pg/mL were designated as "red light," signifying an urgent need for admission due to life-threatening infections. An intermediate "yellow light" indicated further monitoring[1]. In this work, we present a rapid test integrating magnetic separation and electrochemical biosensing on a portable device operated by batteries. Several pairs of anti-TREM-1 antibodies were tested in a magneto-actuated immunoassay, and operating conditions were optimized. We demonstrated that our detection system can distinguish sTREM-1 levels associated with low, moderate and high risk of death. The laboratory prototype comprises two components: (1) a disposable cartridge and (2) a digital reader equipped with an interface for quantitative electrochemical readout. The cartridge's microfluidic system facilitates magnetic actuation, while excess sample and reagents are removed. Within less than one minute, the

digital reader provides quantitative readout of the biomarker levels, which is then displayed on the device's screen and transmitted to the accompanying App via Bluetooth.

The device's performance in classifying sTREM-1 levels is presented. This innovative point-of-care test holds great promise for aiding clinicians in rapid risk stratification and timely decision-making, potentially enhancing child survival outcomes and improving patient management in a variety of fever syndromes and specific diseases.

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Topics

Point-of-care

Mesas, Melania[1]; del Valle, Anaixis[2]; Martí, Mercè[3]; Pallarès-Rusiñol, Arnau[1]; Ferrer-Dalmau, Jofre[1]; Baró, Bàrbara[4]; Bassat, Quique[4]; Pividori, Maria Isabel[3]

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Abstract Title:

Reductase-mimicking nanozymes as innovative labels for signal generation in point-of-care diagnostics

Abstract body:

Point-of-care (PoC) diagnostics have gained significant attention for their role in rapid, on-site detection of infectious diseases, a need that became especially apparent during the COVID-19 pandemic. However, the performance of many PoC platforms remains limited by low analytical sensitivity and high detection thresholds, often resulting in unreliable outcomes. To address these challenges, nanozymes - nanomaterials with enzyme-like catalytic properties - offer a promising route forward. Their robustness under extreme environmental conditions, cost-efficiency, and long-term stability make them attractive candidates for next-generation diagnostic technologies.

While the majority of nanozyme research has focused on oxidase-like activity, this study investigates nanozymes capable of catalyzing reduction reactions, offering new possibilities for the development of biosensors and paper-based assays. In this work, bimetallic nanoparticles were synthesized via a chemical reduction method, using polymer stabilizers such as poly(vinyl alcohol) (PVA). Various molar ratios of metal precursors - including sodium tetrachloropalladate(II) (Na_2PdCl_4) and tetrachloroauric acid ($HAuCl_4$) - were combined to produce bimetallic structures. One example includes gold-palladium nanoparticles with a 1:1 molar ratio. The resulting nanozymes were characterized using techniques such as dynamic light scattering, UV-Vis spectrophotometry and transmission electron microscopy to evaluate their physical and catalytic properties, particularly their ability to catalyze reduction reactions - yielding products with promising analytical applications.

This study illustrates that nanozymes with reduction activity can broaden the spectrum of detectable targets by lowering the limit of detection and introduce innovative catalytic pathways for more reliable analytical signal generation, ultimately enhancing the capability and reliability of PoC diagnostic technologies.

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Topics

Point-of-care

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FLASH PRESENTATION

5th European Biosensor Symposium

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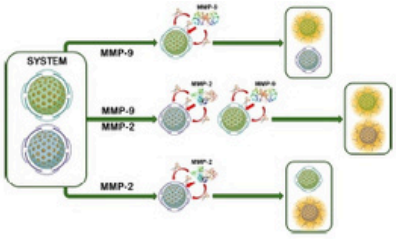
Abstract Title:

Synthesis of gated-mesoporous silica materials for detection metalloproteinases 2 and 9 and the development of paper strips for rapid tests.

Abstract body:

Nowadays, in the diagnosis field, the biomarkers have recently rose its relevance to detect and monitoring several diseases. Quantify the amount of biomarkers allows to track the advance of the disease or the patient response to a treatment. Metalloproteinases (MMPs) are a well-known biomarker, they are involved in degradation of extracellular matrix proteins and several cell processes (angiogenesis, proliferation, etc.). Overexpression of MMPs is normally related to the development of several diseases such as arthritis, ulcer, atherosclerosis, dilated cardiomyopathy, and cancer [1]. Among all MMPs, gelatinases A and B (MMP-2 and MMP-9 respectively) are the most studied MMPs. Related to oncogenic field, both MMPs are overexpressed in many malignant tumours including breast, lung, brain, ovarian, pancreatic and gastric cancer [2]. The MMPs overexpression appears in inflammatory diseases and in Alzheimer's disease too [3]. Due to the key role of gelatinases in biological processes and their association with different diseases, it is important to determine the plasma gelatinase levels.

The project is based on the detection of those MMPs in biological fluid media through peptide-gated materials. Those materials have been loaded with a fluorescent dye, and their external surface has been functionalized with a peptide able to recognise specifically MMP-2 andMMP-9, respectively. The sensing mechanism relies on the degradation of the peptide anchored to the surface of the materials by the MMPs, releasing the fluorescent dye from the pores consequently. With the aim of obtain a final design that allows a rapid, portable and sensitive detection, the materials have been incorporated into sensing strip membranes. Combining the strips systems and a smartphone device that has been developed for the quantification of fluorescence through photography, the project has reached a final dual-plex system that allows an effective quantification of the MMPs simultaneously with all the characteristics that have been mentioned.



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Topics

Point-of-care

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5th European Biosensor Symposium

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Abstract Title:

Synthesis of Various Types of Gold Nanoparticle Conjugates as Reporters in Lateral Flow Assays

Abstract body:

Lateral flow assays are widely used diagnostic tools. A key element in the functioning of these assays is the use of gold nanoparticles conjugated with antibodies. The antibody ensures selective binding to the target antigen, while the gold nanoparticle serves as a reporter. Spherical gold nanoparticles are commonly employed for this purpose due to their relatively straightforward synthesis, unique plasmonic properties, and high stability, which make them well-suited for large-scale production of these assays.

Recently, novel alternatives have been proposed that could replace spherical gold nanoparticles. These emerging options differ in both morphology and chemical composition, including gold nanoparticles coated with iridium [1] or nickel, as well as platinum-based nanoparticles [2]. Non-spherical gold nanoparticles, such as nanostars and nanorods, also exhibit distinctive and promising plasmonic properties. The introduction of such novel nanostructures aims to improve assay performance by lowering the detection limit. In my work, I synthesized gold nanoparticles with various metallic core morphologies. Each nanoparticle type was conjugated with antibodies, and lateral flow assays were constructed to compare the performance of the different nanoparticle conjugates as reporters.

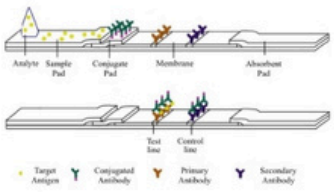

Fig. 1. Schematic representation of the operating principle of a lateral flow assay.

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Topics

Point-of-care

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ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

Towards Resistance-Sparing Approaches: A Lateral Flow Platform for Antivirulence Antibiotic Screening

Abstract body:

Antimicrobial resistance (AMR) is a growing global healthcare crisis, driven by the overuse of antibiotics in human medicine, livestock, and agriculture, as well as inadequate management of antibiotic waste. This has led to the emergence of multidrug-resistant bacteria, increasing both morbidity and mortality [1]. In Europe, it is estimated that AMR causes over 670,000 infections and more than 33,000 deaths each year, with global deaths projected to reach 10 million annually by 2050 without effective intervention.

Conventional antibiotic screening methods rely on measuring bacterial growth inhibition, requiring long incubation times (3.5–16 hours, plus 24–48 hours of pre-culture), and fail to distinguish between bactericidal and bacteriostatic effects. Crucially, they also overlook compounds with antivirulence activity, as agents that disarm bacteria by blocking virulence factor secretion rather than killing the cells. These offer key advantages, including reduced disruption of the host microbiota and lower potential to drive resistance [2].

To address these limitations, we propose a paper-based lateral flow immunoassay (LFIA) for the rapid detection of antivirulence activity through inhibition of exotoxin A secretion in *Pseudomonas aeruginosa*. Candidate antibiotics, including commercial drugs and novel liposomal formulations, will be tested in bacterial cultures using the proposed bioanalytical platform. A lack of signal at the test line indicates successful inhibition of exotoxin A secretion and thus antivirulence potential. For validation, complementary assays such as turbidity measurements and dye exclusion viability tests will be used to distinguish bactericidal effects from antivirulence activity.

We envisage that this platform will enable real-time, dose-dependent analysis of virulence factor secretion, offering mechanistic insights into bacterial quorum sensing. This approach represents a fast, accessible, and informative alternative to conventional screening methods, potentially accelerating the discovery of novel antimicrobial strategies that minimize resistance development.

Acknowledgements

MCINN-24-PID2023-149004OB-I00; RED2022-134120-T; SEK-25-GRU-GIC-24-071; PRE2021–097567 FPI Grant

Abstract References

[1] A. H. Holmes et al., The Lancet, vol. 387, no. 10014, pp. 176–187, 2016. [2] C. Wang et al., Biomedicine & Pharmacotherapy, vol. 153, p. 113334, 2022.

Topics

Point-of-care

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WEARABLES

ORAL COMMUNICATION

5th European Biosensor Symposium

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Abstract Title:

A hydrogel-based wearable device supporting sweat sampling for monitoring sports activities

Abstract body:

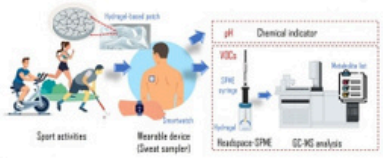
Background. Wearable biosensors are innovative devices designed to monitor physiological signals from the human body. But, a key technical limitation of sampling biological fluids like sweat is its low and variable secretion rate, which can lead to inconsistent real-time measurements and reduced sensitivity. An alternative approach is a punctual health evaluation using advanced materials. Our communication presents a novel hydrogel-based skin patch designed to rapidly absorb and preserve small volumes of sweat, enabling timely and localized determination of pH and biomarkers.

Materials & methods. Hydrogel composition was a blend of poly(vinyl methyl ether-maleic acid) copolymer and polyacrylic acid, crosslinked via ester bonds formed with a pseudopolyrotaxane structure (polyethylene glycol/β-cyclodextrin rings). A pH-sensitive chemical indicator was used to measure the pH. Biomarkers were determined using headspace solid-phase microextraction coupled with gas chromatography-mass spectrometry.

Results. The designed hydrogel had mobile crosslinking points, enabling the sliding-ring mechanism, which imparts exceptional mechanical strength and elasticity. Also, the material swells significantly and molds easily into microneedle patches, increasing the surface area for sweat sampling. Experiments confirmed sweat-capturing capability by measuring its swelling ratio over time, assessing absorption efficiency through volume variation while maintaining structural integrity. Once demonstrated in water and artificial sweat, the hydrogel was tested under real physiological conditions to validate its performance in practical, on-skin applications. The novel hydrogel was integrated into a flexible skin patch and applied to the upper back areas of volunteers. Participants then engaged in physical activity to induce natural sweating. Results demonstrated that the novel sampling material provides valuable data about how sport activity increases skin pH and metabolic byproducts profile.

Conclusions. Potential applications include non-invasive monitoring for disease biomarkers, assessing hydration and nutritional status, and detecting stress or fatigue levels in professional and recreational athletes.

Acknowledgments. Project WEAROPSENS PID2022-140653OB-I00 (MICIU/AEI and ERDF/EU) and PROMETEO 2024-CIPROM/2023/18 (GVA).



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Topics

08 Wearables -

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FLASH PRESENTATION

5th European Biosensor Symposium

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Abstract Title:

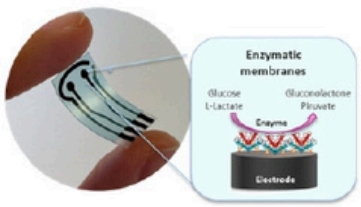
Advancing ICU Care: Continuous Monitoring with Wearable Biosensors for Early Sepsis Detection Using Printed Electronics

Abstract body:

The management of critically ill patients within Intensive Care Units (ICUs) represents a great challenge to global healthcare. Due to the limitation of the current intermittent monitoring systems that have repeatedly shown a delayed recognition of the patients' deterioration, continuous monitoring systems have increasingly gained importance in recent years. By using advanced wearable sensors, real-time data on key parameters can be obtained to enable a prompt detection and treatment of the patient.

One of the techniques that can be used to create the wearable are printed electronics (PE). This technique allows the creation of flexible, skin-compatible devices on different substrates, making wearable technologies a feasible solution with the ability to continuously track vital signs, physiological parameters, and other critical metrics.

In this study, we developed a non-invasive TPU wearable composed of PE-based electrochemical biosensors to monitor glucose and lactate in sweat. The device continuously tracks metabolic markers associated with sepsis, aiming for early detection in ICU patients avoiding potential delays that could lead to organ dysfunction and increased mortality.



The wearable device developed in this work has demonstrated stable and accurate detection of glucose and lactate levels in artificial sweat. The biosensors have shown a high selectivity even in the presence of interferents. In addition, the flexible structure composed of TPU ensures comfort and biocompatibility. Preliminary tests suggest that early metabolic alterations related to sepsis can be detected, supporting the wearable potential to ensure timely and personalized interventions in critical care settings.

Herein, in this study, we harness the potential of PE for medical applications, displaying a fully integrated non-invasive wearable designed for the early detection of sepsis in ICU patients by including electrochemical biosensors for the continuous monitoring of glucose and lactate concentrations in sweat to prevent or revert the fatal metabolic dysregulation in septic patients.

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Topics

Wearables

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POSTER

5th European Biosensor Symposium

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Abstract Title:

Enhancing Bioelectrocatalytic Electrode Performance through Permeability Optimization of Buckypapers for Microcavity-Based Biofuel Cells

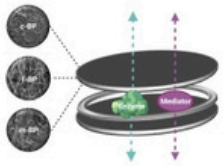
Abstract body:

Enzymatic Fuel Cells (**EFCs**) hold promise as power sources for **wearable electronics and biosensors**. However, efficient enzyme and redox mediator **immobilization** remains a **key challenge**, requiring strategies that maximize current output while minimizing leakage. This study explores a novel **hollow bioelectrode architecture**, wherein the enzyme remains in solution within a **microcavity** formed by two conductive buckypaper (**BP**) sheets—self-standing carbon nanotube (CNT) membranes. Three types of BPs were evaluated: c-BP (industrial CNTs), f-BP (lab-synthesized CNTs), and m-BP (50:50 blend). **SEM** imaging demonstrated structural stability across all BPs, with m-BP achieving a compromise in flexibility and mechanical integrity. **Raman spectroscopy** indicated a higher defect density in c-BP (I_D/I_G = 1.58), followed by f-BP (I_D/I_G = 0.36) while m-BP exhibited intermediate structural features with I_D/I_G = 1.12. **BET surface area** analysis showed c-BP with the highest porosity (243 m²/g), followed by m-BP (122 m²/g) and f-BP (20 m²/g). **Wettability studies** confirmed c-BP's superior hydrophilicity, with m-BP showing moderate wetting.BPs permit water and small molecule diffusion but prevent enzyme permeation. Permeability studies using methylene blue (MB) and FADGDH (as model redox mediator and enzyme, respectively) revealed c-BP and m-BP retained higher concentrations than f-BP. **Electrochemical tests** of each BP with Bilirubin Oxidase/ABTS, FADGDH/MB and FADGDH/PLQ systems, after 24-hour phosphate buffer immersion, gave the following current densities respectively:

1. c-BP: 0.91 mA/cm², 2.0 mA/cm², 3.2 mA/cm²
2. m-BP: 1.7 mA/cm², 1.7 mA/cm², 5 mA/cm²
3. f-BP: 0.95 mA/cm², 0.35 mA/cm², 2.4 mA/cm²

These results highlight **m-BP's optimal balance** between substrate diffusion and retention, and support the concept that m-BP presents a balanced performance profile for EFCs, combining **substrate accessibility with enzyme retention.** The **choice of CNT type** significantly influences BP properties, enabling **tailored electrode designs** for advanced bioelectronic and wearable applications.

Acknowledgment: *Authors would like to thank the National Science Centre, Poland for financial support [2023/49/B/ST4/02942].*



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Topics

Wearables

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Abstract Title:

Insights into ISF-Blood Correlation Dynamics by the Aid of a Novel Microneedle Biosensor

Abstract body:

Interstitial fluid (ISF) has gained attention as an alternative diagnostic medium to blood for continuous and minimally invasive biomarker monitoring (1). However, a major translational barrier remains the lack of a clear and consistent correlation between ISF and blood concentrations of protein biomarkers, particularly under dynamic physiological conditions (2-3). In this work, we introduce a capacitive microneedle-based biosensor capable of real-time, continuous monitoring of cardiac troponin I (cTnI) levels in ISF.

Our platform utilizes microneedles functionalized with anti-cTnI antibodies to detect target binding through changes in electrical double layer (EDL) capacitance at the microneedle–ISF interface. The device enables high-resolution, continuous tracking of cTnI concentration over extended periods, capturing both resting (physiologically stable) and stimulated (elevated cardiac stress) states.

Experimental results revealed that during resting conditions, cTnI levels in ISF closely mirrored those in blood, with only a modest temporal lag (~20–30 minutes). In contrast, under physiologically stimulated states, such as acute cardiac stress, cTnI concentrations in blood were observed to rise significantly faster and reach levels over ten times higher than those in ISF (4). These discrepancies underscore the complex, dynamic kinetics of biomarker transport between compartments and highlight the limitations of static or single-time-point ISF sampling.

Thanks to our developed platform, for the first time we demonstrate the feasibility of continuous cTnI monitoring in ISF (5), which opens a new window into understanding the temporal and physiological variations in ISF–blood biomarker correlation. This capability is critical for advancing ISF-based diagnostics and ensuring reliable clinical interpretation of ISF biomarker data across a range of physiological and pathological conditions.

Abstract References

(1) Kim, Y., Prausnitz, M.R. Sensitive sensing of biomarkers in interstitial fluid. Nat Biomed Eng 5, 3-5 (2021). https://doi.org/10.1038/s41551-020-00679-5 (2) Wang, Z., Luan, J., Seth, A. et al. Microneedle patch for the ultrasensitive quantification of protein biomarkers in interstitial fluid. Nat Biomed Eng 5, 64-76 (2021). https://doi.org/10.1038/s41551-020-00672-y (3) Mirzajani H, Urey H. IDE-Integrated Microneedle Arrays as Fully Biodegradable Platforms for Wearable/Implantable Capacitive Biosensing. IEEE Sensors Letters. 2023 Nov 22;8(1):1-4. (4) Mirzajani H, Zolfaghari P, Koca BY, Urey H. Minimally invasive and in situ capacitive sensing of cardiac biomarker from interstitial fluid. bioRxiv. 2025 May 18:2025-05. (5) Das, J., Gomis, S., Chen, J.B. et al. Reagentless biomolecular analysis using a molecular pendulum. Nat. Chem. 13, 428-434 (2021). https://doi.org/10.1038/s41557-021-00644-y

Topics

Wearables

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POSTER

5th European Biosensor Symposium

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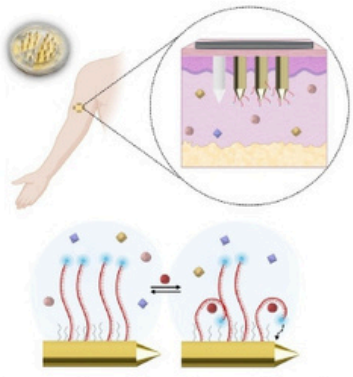
Abstract Title:

Next frontiers in real-time molecular monitoring: an integrated microneedle platform for continuous ISF monitoring

Abstract body:



Recent advances have enabled continuous monitoring of physiological parameters such as heart rate variability, temperature or blood oxygenation, revolutionizing early disease detection and personalized healthcare. The next frontier lies in real-time molecular monitoring[BP1] . For that purpose, non-invasive biofluids like sweat and saliva have shown potential but are often hindered by contamination, weak correlation with systemic levels, and inherent heterogeneity influenced by secretion rate and sampling conditions. In contrast, interstitial fluid (ISF) provides a more robust and representative medium, closely correlating blood composition[1]. Microneedle (MN) technology provides direct, minimally invasive access to ISF, enabling continuous *in situ* sensing. While current ISF sensors typically target redox-active species, electrochemical aptamer-based (EAB) sensors offer the specificity needed for broader biomarker detection. Nonetheless, this technology still faces challenges in its implementation, mostly related to poor sensitivity in the low concentration ranges of ISF, stability in physiological conditions, reproducibility and scalability.

With that in mind, we developed a 3D-printed MN platform with gold-sputtered electrodes for EAB biosensing. The platform includes precise electrode arrangement, electronic connections, a stable pseudo-reference electrode, and restricted aptamer functionalization on the MN tips. The MN platform achieved successful dermal penetration *in-vitro* without compromising the electrode performance. *In-vitro* calibration curves showed sensor's stability and responsiveness to its target. Proof-of-concept *in-vivo* trials in rodent models demonstrated real-time detection of antibiotic targets with minimal signal drift. The system maintained mechanical integrity and consistent electrochemical performance throughout operation. While statistical validation is ongoing, these results highlight the sensor's functionality under physiological conditions and its adaptability to *in-vivo* environments.

This MN-based EAB platform is promising for continuous, minimally invasive molecular monitoring in ISF. Its scalable fabrication, functional robustness, and preliminar *in-vivo* validation support its use in preclinical models, paving the way for next-generation wearable biosensors targeting a wide range of biomarkers for therapeutic and physiological monitoring.

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[1] Friedel, Mark, Ian A.P. Thompson, Gerald Kasting, Ronen Polsky, David Cunningham, Hyongsok Tom Soh, and Jason Heikenfeld. 2023. "Opportunities and Challenges in the Diagnostic Utility of Dermal Interstitial Fluid." Nature Biomedical Engineering. https://doi.org/10.1038/s41551-022-00998-9.

Topics

Wearables

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5th European Biosensor Symposium

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Abstract Title:

Non-invasive wearable transdermal patch: In situ multimodal monitoring of ISF-contained biomarkers for physiological assessment

Abstract body:

Transdermal biosensors represent a transformative advancement in non-invasive physiological monitoring [1]. By enabling access to biomarkers within interstitial fluid (ISF), these sensors provide critical insights into an individual's health and physiological status. The ability to continuously monitor a wide range of biomolecules —including proteins, hormones, and electrolytes—is essential for disease diagnosis, health assessment, and treatment evaluation. Compared to conventional methods such as blood sampling, transdermal biosensors offer a more comfortable and less invasive alternative, potentially enhancing patient compliance and overall quality of life. Moreover, their capacity for real-time, continuous monitoring can significantly reduce diagnostic and treatment delays while also lowering healthcare costs by minimizing the need for frequent clinical visits and laboratory analyses.

This work presents the development of a flexible, fully screen-printed multi-electrode patch that integrates electrochemical and physical sensors for comprehensive physiological monitoring [2]. It has been designed for application on dry skin, measuring temperature, conductivity/ionic strength, pH, and sodium ions. ISF extraction is achieved via reverse iontophoresis, a technique that uses an electric field to mobilize neutral or mildly charged species through electroosmotic flow and ions via electromigration [3], eliminating the need for sweat stimulation. The capability of the individual sensors to detect ISF-contained analytes for physiological assessment has been tested, including a proof-of-concept assessment of dehydration using buffer solutions as well as pig skin models. The patch demonstrated high resolution within the physiological range (135–145 mM sodium) and a broad linear response capable of detecting clinically relevant dysnatremia (130–150 mM sodium) [4], as well as successful measurements of temperature (30–36ºC), pH (5.10–7.07), and conductivity within expected skin ranges.

These results establish a proof-of-concept for a wearable platform capable of monitoring hydration and other biomarkers in real-world conditions. The proposed technology holds promise for diverse applications in health monitoring, sports science, and chronic disease management.

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Acknowledgment This work was financially supported by the Basque Government through Elkartek program (ELKARTEK KK-2023-00009) and from the European's Union Horizon 2020 research and innovation program under grant agreement No 101159927. References [1] W. Gao, S. Emaminejad, H. Y. Y. Nyein, S. Challa, K. Chen, A. Peck, H. M. Fahad, H. Ota, H. Shiraki, D. Kiriya, D. H. Lien, G. A. Brooks, R. W. Davis, and A. Javey, Nature, 529, 509 (2016). [2] Patent Application Nº P233295-EP: Device and method for biomarkers concentration monitoring and use thereof. [3] Leboulanger, B., Guy, R. H., & Delgado-Charro, M. B. (2004). Reverse iontophoresis for non-invasive transdermal monitoring. Physiological measurement, 25(3), R35. [4] Bianchetti, M. G., Simonetti, G. D., & Bettinelli, A. (2009). Body fluids and salt metabolism-Part I. Italian journal of pediatrics, 35, 1-6.

Topics

Wearables

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Abstract Title:

Physical printed and stamped hybrid graphene sensors for implantable prosthetics and other applications

Abstract body:

Musculoskeletal-non-communicable diseases (MSK-NCDs) are a group of disorders that affect the bones, joints, muscles, and connective tissues, particularly in older adults. Musculoskeletal (MSK) diseases in the elderly demonstrate a significant public health issue worldwide. As the global population ages, the incidence and prevalence of MSK diseases are increasing. In the elderly population, the most common MSK disorders include osteoarthritis, rheumatoid arthritis, osteoporosis, and fragility fractures. These conditions lead to chronic pain, loss of mobility, and functional impairment, which substantially affect the quality of life. The Smile project aims to reduce the burden of MSK diseases in the elderly by developing novel technological solutions, empowering patients to manage/monitor their own MSK health and enabling personalized treatments by health care providers (HCPs).

Temperature and strain are two important variables in implanted prosthetics, the first being connected to infection and inflammation processes, and the second helping defining the mechanical solicitations that the prosthetic receives. Standard commercially available temperature and strain sensors, hardly comply with the integration and design requirements imposed by the different shapes of the implanted exo- and endo-prosthetics. Therefore, printed silver and stamped hybrid graphene sensors with integrated electronics and wireless data transfer [1] are a valid option for this very specific application. Here we present the development of these sensors on flexible substrates and their preliminary testing in controlled laboratory conditions. Furthermore, we treat the difficult topic of proper encapsulation to prevent negative effect of the health of the patient preserving a good performance of the sensors.

Abstract References

[1] G. Maroli et al. 2024 Biosensors and Bioelectronics, vol. 260, 116421. https://doi.org/10.1016/j.bios.2024.116421

Topics

Wearables

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ORAL COMMUNICATION

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Abstract Title:

Silk-Based Radiochromic Sensing Patch for On-site X-ray Dosimetry

Abstract body:

X-ray radiation is a powerful tool for medical diagnostic applications . In medicine, X-rays are particularly important for radiotherapy, where precise dose control is essential to ensure treatment effectiveness and minimize damage to healthy tissue [1-2]. However, commercially available dosimeters are often rigid and incompatible with flexible or wearable formats for on-site analysis [3-4].

In this work, we present a novel flexible and biocompatible radiochromic sensor patch based on silk fibroin and polydiacetylene (PCDA) for colorimetric sensing of X-ray exposure in-situ. The system is prepared by mixing PCDA with silk fibroin solution and casting it into thin films. Upon exposure to ionizing radiation, PCDA monomer undergoes into a blue coloured polymer, resulting in optical density (OD) change. The colorimetric response is quan-titatively analyzed using a flat-bed scanner and camera set-up, showing a relationship between the dose and the optical density.

The developed films were characterized in terms of mechanical strength and integrity, dose sensitivity, and optical response under various doses. The films were conformational and adapted to the body shape. They also demonstrated a clear and progressive color change with increasing radiation doses, confirming their potential as low-cost portable dosimeters. Additionally, cytotoxicity assays were performed on humal adult dermal fibroblast cells to assess the biocompatibility of the sensing films, revealing excellent cell viability before and after irradiation.

This flexible, biocompatible, and cost-effective platform offers a promising solution for on-site X-ray monitoring in medical settings, and may contribute to the development of next-generation wearable radiation sensors.

Abstract References

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Topics

Wearables

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