Anindita Ganguly

Research Statement

Introduction

In an era where precision medicine and personalized treatment are gaining prominence, my research focuses on leveraging the advantages of electrochemical techniques to develop highly sensitive, selective, and portable sensors for disease diagnosis, real-time monitoring, and improved patient care. My research seeks to answer questions like *how can electrochemical techniques be harnessed to develop highly sensitive and selective sensors for detecting drugs in pharmaceutical wastewater, what are the potential applications of portable electrochemical sensors in the field of biomedicine, and how can the data collected from electrochemical sensors be integrated into healthcare systems to support personalized treatment procedures.* I have made significant contributions in addressing the questions above, particularly in drug detection [1, 2, 3, 4] and biomolecular detection [5] by harnessing the power of electrochemical techniques and green energy harvesting, addressing critical challenges in both fields. In future, I hope to make significant contributions in the field of biomedicine for accurate diagnosis of common diseases through innovative surface modification of biomaterials, tackling questions like *how can the development of sensitive and selective electrochemical sensors improve disease diagnosis and personalized medicine*.

Previous Research

During my Ph.D. (2018-2022) at the National Taipei University of Technology (NTUT), Taiwan, I was actively engaged in the design and characterization of electrochemical sensors for various environmental and healthcare applications. My prior research was primarily focused on the detection of antibiotics [1] and phenolic compounds [6, 7] from environmental samples. I also worked on glucose detection and testing the biocompatibility of materials used for biosensing applications. In addition, I gained experience in materials synthesis, surface functionalization, and characterization, especially in carbon-based reduced graphene oxide, multi-walled carbon nanotubes, and transition metal chalcogenides. Furthermore, I have also contributed to the development of sensitive and selective electrochemical platforms for detecting compounds that lead to the growth of multiple drug-resistant microorganisms in the aquatic environment. Apart from research, I was also involved in mentoring and teaching the graduate and undergraduate students on their projects and courses respectively. I jointly taught two graduate courses on Advanced Biomaterials and Nanotechnology with Prof. Kuo Yuan Hwa. Before starting my Ph.D., I worked on developing a protein-based molecular needle for anti-cancer drug delivery in India. I worked on recombinant protein expression, his-tagged protein purification, and characterization. During this time, I designed and executed a multitude of in-vitro experiments in several cell lines (HeLa, MCF-7, NIH-3T3, NCTC-929, SW620), and chemical modifications to form protein-dye conjugates. In the future, I would like to leverage this experience in biosensor development for the identification of biomarkers for disease diagnosis.

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Current Research

Currently, I am a Post-Doctoral research fellow at the National Taiwan University (NTU, Taiwan) working on self-powered biochemical sensing devices and triboelectric nanogenerators used for green energy harvesting. Building upon my previous experiences, my current research focuses on pushing the boundaries of electrochemical sensor technologies in biomedical applications. These healthcare sensors offer enhanced sensitivity, specificity, and multiplexing capabilities while harnessing the human body heat as the source of power. The developed sensors addressed the critical needs of disease diagnosis, real-time monitoring, and personalized treatment while also contributing to environmental sustainability. Moreover, I have worked extensively on the synthesis and characterization of thermoelectric and piezoelectric materials for wound healing [a paper submitted to *Nano Energy* is under review] and green energy harvesting. Additionally, I am responsible for mentoring 12 graduate students in our research group including 2 students from minority communities.

Future Research

Coming to my future research objectives, I would like to work at the intersection of electrochemical sensors, biomaterials, polymers, and biosensors for the advancement of the healthcare industry. I plan to design and optimize electrochemical sensors to detect specific biomarkers associated with various diseases. By exploring novel electrode materials, signal amplification strategies, and immobilization techniques, I aim to enhance the sensitivity and selectivity of the sensors, enabling accurate and early disease diagnosis. I would also like to focus on Point-of-Care testing technologies to contribute towards the development of portable and user-friendly electrochemical sensor systems. These devices will allow for rapid and on-site diagnostics, enabling healthcare professionals to make timely treatment decisions and improve patient care. Next, I would like to explore the integration of electrochemical sensors into wearable devices for real-time monitoring of vital signs, biomarkers, and drug levels. These biosensors will enable personalized and non-invasive healthcare monitoring, aiding earlier intervention and precise treatment. Finally, I would like to contribute to the integration of biofunctionalized interfaces, including nanomaterials or biomolecular recognition elements that will enhance the sensitivity and selectivity of sensors. These interfaces will allow for the precise and consistent detection of biomolecules, as well as the translation of sensor technologies into clinical settings.

In conclusion, my research was focused on impacting the field of biomedicine by developing innovative and efficient chemical sensors for improving human health, aiming to mitigate pharmaceutical pollution and contributing to sustainable practices. In the near future, I would like to go further with the development of highly sensitive, selective, and portable sensors for disease diagnosis, real-time monitoring, and personalized medicine. This future work has the potential to not only improve patient care, and enable early intervention, but also support personalized treatment procedures. By collaborating with healthcare professionals, industry partners, and regulatory bodies, I am committed to driving transformative advancements in translating research findings into practical applications that will improve patient outcomes, paving the way for a healthier future.