Materials Horizons

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Cite this: DOI: 10.1039/d0mh90062a

Horizons Community Board Collection: Biosensors

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DOI: 10.1039/d0mh90062a

rsc.li/materials-horizons

Materials Horizons and *Nanoscale Horizons* set up their Community Boards several years ago, aiming to support early career researchers so that they can share their experiences and ideas on scientific publishing. As future leaders in their respective fields, the Community Boards also provide a channel for members to build relationships across their research community and develop their own editorial skills.

This collection continues a series of post-publication online article collections, led by our Community Board members across both *Materials Horizons* and *Nanoscale Horizons*.

Working together and sharing their unique areas of expertise, our Community Board members have recommended several key topics where significant, rapid progress has been made in the last 2 years. They have selected top articles published in the Horizons journals to showcase the most important advances in each topic area.

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Zhiyuan Liu

Nanoscale Horizons Community Board Member Zhiyuan Liu is currently a professor at Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China. He received his BS from Harbin Institute of Technology and was awarded his PhD in Materials Science and Engineering in 2017 from Nanyang Technological University, Singapore. During that time, he worked with Prof. Xiaodong Chen in Singapore and Prof. Zhenan Bao at Stanford University. His focus is on the research of soft/stretchable bio-interfacial devices and he is experienced in interdisciplinary study. He was awarded a Materials Research Society (USA) Graduate Student Award (Gold) in 2018. He also received a Chinese Government Award for Outstanding PhD Student Abroad in 2018 and Materials Research Society Award (Singapore) for Outstanding PhD Student in 2017. He hopes his research could facilitate the fusion of humans and external machines.

Gift Mehlana

Gift Mehlana holds a BSc Hons degree in Chemical Technology from the Midlands State University in Zimbabwe. Gift Mehlana completed his doctoral studies at the University of Cape Town in 2014. His research focused on the preparation of novel metal–organic frameworks for applications in sensing small molecules through visible colour changes. At the moment, Gift Mehlana is a Future-Leaders African Independent Research fellow at Midlands State University. This fellowship is for talented African early career researchers who have the potential to become leaders in their field. Mehlana leads a research group at Midlands State University which focuses on developing novel metal–organic frameworks for sensing, catalysis and drug delivery.

Biosensing

The development of sensing technologies has been one of the prime focuses of recent research. In this area, scientists have developed different types of materials for use in biosensing, analyzed different biological targets and specimens, and combined nanoscale developments with the macroscopic world for real-life applications. In this collection, we have compiled a list of articles that discuss these developments in the area of biosensing.

Many new developments in biosensing begin with the detection or identification of disease biomarkers and biological targets, such as nucleic acids (microRNAs, gene fragments) and proteins (tumor-related proteins, for example). Over the years, scientists have utilized nanomaterials in biosensing for their favorable optical properties and functionality. These materials range from metal oxide nanoparticles (DOI: 10.1039/C7MH00804J) to molecular materials such as DNA (DOI: 10.1039/C8MH01151F) and liposomes (DOI: 10.1039/C9NH00097F). Such sensors have been deployed for use in cancer diagnostics (DOI: 10.1039/D0NH00258E), *in vivo* temperature mapping (DOI: 10.1039/C9NH00693A) and cardiovascular diseases (DOI: 10.1039/C8MH01293H).

Towards more practical uses of biosensors, scientists have developed soft and stretchable bio-sensing elements. These are crucial for human body-integrated, long-term, real-time monitoring of biological information including bio-electrical, bio-mechanical and bio-chemical signals. Since human tissues, like skin and other organs, are intrinsically soft and stretchable, devices that integrate with these tissues are required to be soft and stretchable to achieve mechanical matching. Materials like hydrogels play an important role due to their softness and multi-functionality. However, new functions of hydrogels should be further developed for biosensing, *e.g.* anti-drying, self-healing (DOI: 10.1039/C8MH01160E), tissue adhesion (DOI: 10.1039/D0MH00361A) and triggerable properties (DOI: 10.1039/D0MH00862A). These new properties make hydrogel-based soft electronic devices more diverse and adaptable for biosensing applications. Other than hydrogels, modified elastomers with higher strength are also important, especially for bio-mechanical sensors, such as polyionic elastomers (DOI: 10.1039/C8MH01157E) and others structured for high-sensitivity pressure sensors (DOI: 10.1039/C9NH00671K). For the future, soft biochemical sensing is vital for healthcare monitoring; however, it is less reported than other biosensors due to the challenges of specificity, selectivity and stability. A novel noninvasive glucose sensing strategy has been reported (DOI: 10.1039/D0NH00098A), but more bio-molecular sensing methods are still waiting to be investigated.

One other area of biosensing is bioelectronics, a developing field at the interface of the life and physical sciences which connects biological systems with conventional electronics such as semiconductors in a bid to create new medical therapies. One of the key underlying challenges in bioelectronics is to transduce between the predominantly ionic signals of biology and the electronic signals of semiconductors. To this end, various strategies have been developed to address this challenge. The proton conducting biopolymer melanin and a p-type organic electrochemical transistor (OECT) have been developed as a solid-state transducing interface capable of computing at the biology–electronic interface (DOI: 10.1039/C7MH00831G). Molecular antennas have also been introduced on organic thin-film transistors to produce a bioelectric sensor interface that allows for direct interactions between the semiconductors and the target analytes in solution (DOI: 10.1039/C7MH00887B). The majority of studies have focused on the use of p-type OECT to produce bioelectric sensors; recent studies show that the use of n-type OECT could pave the way for the development of next-generation biosensors and bioelectronic hybrids (DOI: 10.1039/D0MH00548G). This collection of articles will provide some insight into recent developments in biosensing and the adaptability of ongoing lab-based research for practical applications.

Read the collection here.

Arun Richard Chandrasekaran

Arun Richard Chandrasekaran received his BSc in Zoology from The American College in Madurai, India and his MTech in Nanoscience from the University of Madras in Chennai, India. He moved to the US for his PhD with Ned Seeman at New York University, where he worked on designer DNA crystals and triple helical DNA. For his postdoctoral work, he worked with Ken Halvorsen at the University at Albany (SUNY), where he developed DNA nanoswitches for biosensing applications. Currently, Arun is a research scientist at The RNA Institute at SUNY Albany. His research interests include functionalization of DNA nanostructures for drug delivery and biosensing, structural analysis of DNA nanostructures, and DNA-encoded memory devices. He is also keen on writing science for a lay audience and has written for the magazine The Scientist and runs the science blog "Stranded".