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Introduction to bioinspired surfaces engineering for biomaterials

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Although huge success has been achieved with biomaterials in the promotion of human health, there remain many challenges in biomaterials research and applications. For instance, most synthetic materials used in medical devices elicit non-specific responses from biological systems upon implantation, which further trigger a series of unwanted reactions, including thrombi, inflammation, foreign body reactions, *etc.* The most straightforward strategy to solve the problem could be the surface engineering of biomaterials with new functionalities to achieve better clinical performance.

Understanding the sophisticated functionalities offered by objects and processes presented in nature will guide the design of materials with desirable properties to meet challenging applications. Zwitterionic and other bioinspired materials, mimicking biological structures and functions at different

G. Julius Vancso

Prof. G. Julius Vancso earned his PhD in 1982 in Solid State Physics (Eötvös Loránd University of Sciences, Budapest). He then studied materials science at the Swiss Federal Institute of Technology (ETH-Zürich) and joined the faculty of the Chemistry Department of the University of Toronto in 1988. He moved to the University of Twente in the Netherlands in 1994 to occupy the Chair in Materials Science and Technology of Polymers as full professor. Since October 2020, he has been Emeritus Chair and part time Research Professor at Twente University, and Visiting Professor at Nanyang Technological University in Singapore (School of Materials Science and Engineering). Julius Vancso is External Member of the Hungarian Academy of Sciences, and Fellow of the Royal Society of Chemistry, UK. His current scientific interests revolve around the materials chemistry of stimulus responsive and engineered polymers, surface engineering and antifouling materials, and macromolecular nanotechnology. He is also co-founder and CEO of Sulis Polymers Ltd., a spinoff company specializing in polymer research for biomedical and engineering applications.

Jian Ji

Prof. Jian Ji received his PhD degree from Zhejiang University in 1997 and became a full professor in 2004. His research focuses on the interfacial materiobiology of biomedical implants, tissue engineering and nanomedicine. He has explored several bioinspired methods to develop biocompatible and biofunctional surfaces for biomedical applications. Following the data-driven approach to the biomaterials genome initiative, innovative surface modification methods were combined with high-throughput experimental technology and machine learning to reveal the quantitative laws of the synergistic function of different surface properties. This research broke through the technical bottleneck of the construction of complicate bioinspired surfaces, and realized "Bench to Bedside" applications in interventional biomedical devices.

levels (*e.g.*, cell membranes, proteins, tissues, *etc.*) have shown great potential in the surface engineering of biomaterials for applications such as diagnostic, drug delivery, and tissue regeneration.

Poly(2-methacryloyloxyethyl phosphorylcholine) (PMPC) is a representative example of a zwitterionic bioinspired material, mimicking the lipid membranes on the outer surface of cells. PMPC has been found to have many merits due to its biomimicking zwitterionic structure, especially superior hemocompatibility and biocompatibility. Till now, PMPC based coatings have been successfully applied on many clinically approved medical devices, including extracorporeal membrane oxygenation (ECMO), ventricular assist devices and endovascular stents.[1] Zwitterionic poly(carboxybetaine) (PCB) is another representative material, which was inspired by glycine betaine, an osmoprotectant widely present in biological systems. Due to its superhydrophilicity, the PCB surface forms a strong hydration layer that prevents nonspecific adsorption from proteins. This so-called ultralow fouling property makes PCB a promising biomaterial for a wide range of applications.

Layer-by-layer (LbL) assembly technology was introduced by Decher and Lvov in the early 1990s, and has been extensively studied to mimic the extracellular matrix (ECM) for the purpose of creating a biomimetic cellular microenvironment. Due to its flexibility and multipotency, LbL shows great potential to mimic not only the biochemical, topological, and mechanical properties of the ECM, but also the highly dynamic assembly that is constantly undergoing remodeling in response to various stimuli, particularly during cell development and tissue healing regeneration. The field has moved from simple mimicking to the active control of various cellular behaviors.[2]

In this context, it is pertinent to compile this themed collection focused on the recent rapid development in

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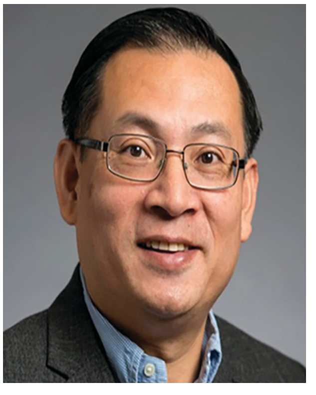
Prof. Kazuhiko Ishihara received his PhD degree from Waseda University, Tokyo, Japan in 1984. He was an associate professor at the Tokyo Medical and Dental University. Then, he was made professor in the Department of Material Engineering, The University of Tokyo from 2000 to 2021, and is now an emeritus professor. His specialties are the molecular design of functional polymers, biomaterials science and engineering, and photochemistry of polymer systems. He has developed bioinspired phospholipid polymers as biomaterials, which have been applied to medical devices worldwide. He has received numerous scientific awards in the field of polymers and biomaterials, and commendations from the Japanese government.

M. Cristina L. Martins

Cristina Martins (Martins, MCL) is an expert in the development of biomaterial coatings designed at the nanoscale using self-assembled monolayers (SAMs) and biomedical polymers. She is Principal Investigator at INEB/i3S (Instituto Engenharia Biomédica/Instituto de Investigação e Inovação em Saúde; www.i3s.up.pt) and Invited Assistant Professor at the University of Porto, Portugal (ICBAS - Instituto de Ciências Biomédicas Abel Salazar). Cristina Martins is the leader of the research group on BioEngineered Surfaces. Her group is investigating the effect of surface immobilized ligands (proteins/peptides, fatty acid like and glycosylated compounds) in the guiding of specific protein/cell binding to control bacterial adhesion (e.g., for gastric infection or osteomyelitis prevention) and/or thrombus formation. Scopus Author ID: 7402262354. https://scholar.google.pt/citations?user=zTnuO7YAAAAJ&hl=en.



Shaoyi Jiang

Shaoyi Jiang joined the Meinig School of Biomedical Engineering at Cornell as the Robert S. Langer '70 Family and Friends Professor in June 2020. Before Cornell, he was the Boeing-Roundhill Professor of Engineering in the Department of Chemical Engineering and an adjunct professor of Bioengineering at the University of Washington, Seattle. He received his PhD degree in chemical engineering from Cornell University in 1993. He was a postdoctoral fellow at the University of California, Berkeley between 1993 and 1994 and a research fellow at the California Institute of Technology between 1994 and 1996, both in Chemistry. He is currently an executive editor for Langmuir, an associate editor for Science Advances, a fellow of the American Institute of Chemical Engineers (AIChE), and a fellow of the American Institute for Medical and Biological Engineering (AIMBE). He received the Braskem Award for Excellence in Materials Engineering and Science, AIChE (2017). His research focuses on zwitterionic materials, surface coatings for medical devices, hydrogels for regenerative and precision medicine, and drug delivery for cancer immunotherapies.

bioinspired surface engineering of biomaterials. This themed collection of *Journal of Materials Chemistry B* aims to cover the recent progress on zwitterionic materials specifically and other bioinspired biomaterials more broadly, including the synthesis, fabrication, properties, and applications of materials and surfaces related to biology and medicine.

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