Biomaterial Surfaces & Interfaces

Room Naupaka Salon 5 - Session BI-MoM

Biomaterials/Interfaces - 3D Systems

Moderator: Jenny Malmstrom, University of Auckland

10:20am **BI-MoM-8 Development of Joint Organoids for the Study of Tissue Integration and Immune Responses***, **Gabriella Lindberg**, M. Hofmann, N. Shchotkina, S. South, N. Willett,* University of Oregon **INVITED**

Despite significant advancements in the design of cell-instructive hydrogels to help repair damaged joint tissues with low metabolic activity, such as cartilage, challenges persist in translating these technologies to clinical applications. This presentation will address two key clinical hurdles in cartilage tissue engineering, focusing on articular conditions, particularly osteoarthritis. The first challenge involves insufficient lateral integration between implanted tissue engineered samples and host cartilage, limiting structural integrity and long-term success. The second challenge is reproducing whole-joint disease conditions *in vitro* with patient-specific inflammatory conditions to accelerate the study of immunomodulatory hydrogels therapies.

To tackle these long-standing translational challenges, we've firstly designed a 3D-model to study tissue integration at the surface between mature cartilage tissues. Herein, we designed ECM-hydrogels that enhance integrative cartilage repair strategies using Vitreous humor, Lysyl-oxidase-like-2, and copper to bridge the two tissue surfaces. Secondly, we have employed modern biofabrication tools, including microfluidic technologies and volumetric printing, to recapitulate dynamic interactions between inflammatory cells and diseased cartilage tissues in the joint space, especially at the surface of the tissue. Utilizing our biobank of human cells and tissue samples together with these organo-typic models has allowed us to study demographical factors (age and sex) that may contribute to differences in OA disease pathogenesis and recovery. Cellular health, tissue formation, multiplexed proteomics assays, and spatial transcriptomics have been used to analyze the biological outcomes across our hydrogel platforms.

This series of studies allowed us to develop hydrogels proficient to guide cartilage repair across a variety patient-centric condition. Ultimately, this talk will highlight some of the important advances in hydrogel design for more clinically-relevant cartilage repair and precision medicine, including integrative hydrogels and immunomodulatory hydrogels together with biofabricated 3D-models to inform regenerative needs in catabolic joint environments.

11:00am **BI-MoM-10 Metrology of 3D Cell Culture Systems***, **Sally McArthur**,* Deakin University, Australia

In developing 3D cell culture systems for evaluating biomaterials we need to create the matching metrology systems that are reproducible as well as giving us insights into the cells, matrices and biomaterials responses. This talk will explore the challenges, solutions and remaining issues associated with creating versatile, scalable and measurable systems.

Biomaterial Surfaces & Interfaces
Room Naupaka Salon 5 - Session BI1-MoE

Biomaterials/Interfaces - Characterization
Moderator: David G. Castner, University of Washington

5:40pm **BI1-MoE-1 Advanced BioAFM for Temporal Analysis*, Amy Gelmi,*** RMIT University, Australia **INVITED**

Electrical stimulation, a physical stimulation which can be delivered via a conductive biomaterial interface, directs human mesenchymal stem cell (hMSC) differentiation towards different cell tissue types.[1] Electrical stimulation conditioning offers a promising approach in directing stem cell fate. Conductive biomaterials are commonly used to provide either a passively conductive substrate, or actively provide 'smart' electrical stimulation of stem cells for tissue engineering. However, the mechanisms in which cells transduce these electrical signals into specific phenotype differentiation are poorly understood, restricting the intelligent design of stimulation protocols for targeted differentiation.

How the stem cells transduce an electrical signal into a biological response is explored via different classes of conductive biomaterials. Immediate changes in the stem cells during and post-stimulation is characterised, using live cell bio-AFM for morphological and biomechanical changes, complemented with standard biological characterisation. The advanced bioAFM technique delivered unprecedented intracellular biomechanical information of live cells undergoing simultaneous electrical stimulation.

For the first time we have characterised the transient mechanical response of hMSC to electrical stimulation, and related that to controlling stem cell differentiation towards osteogenesis. The knowledge gained from this study helps to further the intelligent design of stimulation parameters for targeted differentiation outcomes when using a conductive biomaterial.

[1] Gelmi, A., Schutt, C. E., Stimuli-Responsive Biomaterials: Scaffolds for Stem Cell Control. Adv. Healthcare Mater. 2020, 10, 2001125.

6:20pm **BI1-MoE-3 GCIB-SIMS Analysis of Skin Cancer Samples*, John S. Fletcher,*** *K. Sjögren Cehajic, K. Dimovska Nilsson, O. Zaar, D. Katasarelias, J. Paoli, R. Olofsson Bagge, N. Neittaanmäki,* University of Gothenburg, Sweden

The use of gas cluster ion beams (GCIBs) for secondary ion mass spectrometry (SIMS) analysis provides softer ejection of biomolecular ions and has created opportunities for meeting the challenges of clinical researchers who require chemical specific imaging of different sample type from cells to tissue biopsies. Here we use a J105 Buncher-ToF SIMS instrument (Ionoptika Ltd, UK) to perform in situ lipidomics of skin cancer samples. GCIB-SIMS analysis enabled detailed spatial-lipidomics that could be directly correlated with conventional histopathological analysis of consecutive H&E slides. Here we present work where melanoma cancer samples were the target in order to investigate the chemical changes associated with disease progression and also to investigate if different metastatic pathways could be distinguished based on the chemical signature of the tumours. Primary tumours were analysed along with "healthy/normal" skin from the same subject along with metastatic tumour samples that had spread via either the lymphatic system or through the blood. Significant differences in the lipid profiles were found in primary compared to metastatic melanomas, notably an increase in phosphatidylethanolamine lipids relative to phosphatidylinositol lipids and an increase in GM3 gangliosides in the metastatic samples. Furthermore, analysis of the data from in-transit versus distant metastases samples highlighted that specific glycerophospholipids, and a difference in the long versus shorter chain GM3 gangliosides, discriminated the metastatic routes. The data is also compared to other skin cancer samples including such as aggressive basal cell carcinoma. Challenges related to data processing and spectral annotation are also discussed.

6:40pm **BI1-MoE-4 Depth Correction of 3D SIMS Depth Profiling Images of Biomaterials Using Only Secondary Ion Signal Intensities*, M. Brunet, B. Gorman, Mary Kraft,*** University of Illinois Urbana-Champaign

We have developed a depth correction strategy for three-dimensional (3D) SIMS depth profiling images of biomaterials that solely employs secondary ion signal intensity. In this approach, the secondary ion images that were collected during depth profiling are used to create a model of the sample's morphology at the time that each depth profiling image was acquired. Then these models of the sample's morphology are used to shift the voxels in the 3D image to the correct z-position. Comparison of the morphology models created using the secondary ions and the secondary ion images the usage of secondary ion signals with high intensities tends to produce more accurate morphology models. However, even 3D SIMS images that were depth corrected using secondary ions with relatively low intensities were more accurate than uncorrected 3D SIMS depth profiling images. This ability to use secondary ion images to depth correct 3D SIMS depth profiling images in the absence of correlated measurements of sample topography or knowledge of sputter rate expands the range of SIMS depth profiling data sets that may not be depth corrected.

7:00pm **BI1-MoE-5 Label-Free High-Resolution Molecular Imaging of Sex Steroid Hormones in Zebrafish by Water Cluster Secondary Ion Mass Spectrometry (Cluster SIMS)*, Kate McHardy,*** *N. Sano,* Ionoptika Ltd., UK*; E. Lau, M. Bailey,* University of Surrey, U.K.

Sex steroid hormones are essential biomolecules for vertebrates and are involved in the maintenance of pregnancy, development of secondary sexual characteristics and diseases such as osteoporosis and breast cancer. Visualising the distribution of steroids contributes to further understanding of disease. However, analysis of steroids is difficult; their low polarity leads to poor ionisation efficiency, meaning they need to be derivatised for conventional analyses. Furthermore, the steroid signals overlap with a MALDI matrix background.

Water Cluster SIMS is a high-sensitivity mass spectrometry technique for imaging complex-mixture materials without derivatisation or the use of matrix. We demonstrate imaging of sex steroid hormones in zebrafish (an ideal vertebrate model organism) with a Water Cluster SIMS instrument.

An adult female zebrafish was prepared for this work. It was embedded while fresh in 0.75% HPMC and 0.25% PVP embedding media to facilitate sectioning. The whole block was flash-frozen in a dry-ice and isopropanol bath. The sample was sectioned to 20 µm at -25 °C and thaw-mounted onto a conductive indium-tin-oxide (ITO) coated glass. The section was dried while frozen in a vacuum desiccator, and then directly analysed without any matrix application for the analysis. The Cluster SIMS analyses were then performed with the J105 SIMS Cluster SIMS (Ionoptika Ltd), using a 70 keV $(H_2O)n$ beam, where n is in the range of 15,000-35,000, and also separately with a 40 keV C_{60} beam. High-resolution images were acquired with a pixel size of < 1 micron.

Water Cluster SIMS uses a high-energy beam of ionised clusters of water to sputter and ionise molecules from a surface. It is far less damaging and generates far fewer fragment ions than traditional ToF SIMS, but retains many of the benefits of that technology such as high-spatial-resolution imaging. As a result, detailed images of the distribution of sex steroid hormone molecules in the zebrafish are visible. Preliminary data shows that it is possible to map the chemical distribution of steroids in the ovary area. In addition, we also detected lipid ions related to the embryo or oocyte around the ovary area as unique distributions.

Biomaterial Surfaces & Interfaces
Room Naupaka Salon 5 - Session BI2-MoE

Biomaterials/Interfaces - Sustainable Materials
Moderator: Gabriella Lindberg, University of Oregon

7:40pm **BI2-MoE-7 Development of an Active Sustainable Polymer Based on Crosslinked Gelatin*, Monique Lacroix,*** INRS Armand Frappier Health Biotechnology, Canada

Gelatin is a potential sustainable polymer for packaging development. Due to its biological origin this polymer is highly biocompatible and biodegradable. However, films based on gelatin have poor mechanical properties, high water solubility and permeability. Crosslinking reaction can help to overcome these limitations. In this study, ionization as a non - toxic physical treatment has been used to induce gelatin crosslinking reaction in presence of riboflavine to improve the functional properties of this biopolymer. Riboflavine is a photosensitive compound who can promote crosslinking of proteins during ionization treatment. Concentrations from 0.3 to 1.2 % of riboflavine have been used and doses from 5 to 15 kGy have been applied. Results demonstrated that 0.75% of riboflavine and a dose of 5 kGy were the optimal conditions to improve positively the tensile strength, the water resistance and water barrier properties of the films. The infrared spectroscopy evaluation suggests the formation of a more compact protein structure. A mixture of essential oils and silver nanoparticles were then added in the crosslinked gelatin before film formation. The active film was used for a *in situ* test on fresh meat. Results showed that this active film can increase the shelf life of the fresh meat by more than 6 days. This study suggests that crosslinking of gelatin during ionization treatment in

presence of riboflavine is an effective green technology for the development of sustainable bioactive packaging.

8:00pm **BI2-MoE-8 Sustainability Inspired Development of Next Generation Neural Interfacing and Neurostimulation Electrodes via Reactive Hierarchical Surface Restructuring***, **Shahram Amini**,* Pulse Technologies Inc.*; S. Shahbazmohamadi, H. Choi, A. Blagojevic, M. Maniscalco, P. Tavousi,* University of Connecticut

Over the last two decades, platinum group metals (PGMs) and their alloys have been the preferred materials for electrodes in long-term implantable neurostimulation and cardiac rhythm management devices due to their superior conductivity, mechanical and chemical stability, biocompatibility, corrosion resistance, radiopacity, and electrochemical performance. Despite these benefits, the manufacturing processes for PGMs are extremely costly, complex, and present potential health hazards. Additionally, the volatility in PGM prices, high supply risk, and their scarce concentration of approximately 0.01 ppm in the earth's upper crust, combined with limited mining geographical areas, highlight their classification as critical raw materials. Effective recovery or substitution of PGMs is thus of paramount importance. Since postmortem recovery from deceased patients and refining PGMs used in electrodes and microelectrode arrays is rare, challenging, and costly, the substitution of PGM-based electrodes with other biocompatible materials that can match or surpass their electrochemical performance is the only viable and sustainable solution. In this context, we demonstrate for the first time how the novel technique of “reactive hierarchical surface restructuring” can be applied to titanium—widely used in non-stimulation medical device and implant applications—to create biocompatible, low-cost, sustainable, and high-performing neurostimulation and cardiac rhythm management electrodes. Our study shows that titanium electrodes, which initially exhibit poor electrochemical performance, undergo significant compositional and topographical transformations through this technique, resulting in electrodes with outstanding electrochemical performance. This innovation offers a promising path to reducing and ultimately substituting PGMs in long-term implantable neurostimulation and cardiac rhythm management devices.

8:20pm **BI2-MoE-9 Dynamic Supramolecular Gels for 3D Cell Culture***, A. Chalard, H. Porritt,* University of Auckland, New Zealand*; A. Taberner,* The University of Auckland, New Zealand*; J. Fitremann,* CNRS, France*; **Jenny Malmstrom**,* University of Auckland, New Zealand

Cells sense and adapt to forces and physical constraints imposed by the extra cellular matrix. Such mechanotransduction plays a crucial role in cell function, differentiation and cancer. In our research group we are developing materials to achieve spatiotemporal control over mechanical properties.

Stiffness patterning of hydrogel scaffolds, through the use of stiffness gradients for instance, allows the modelling and studying of cellular responses to fibrotic mechanisms. Gelatine methacryloyl (GelMA) has been used extensively in tissue engineering for its inherent biocompatibility and the ability to precisely tune its mechanical properties. We have developed a method to photopattern the mechanical properties of GelMA hydrogels with visible light and using physical photomasks and projection with a digital micromirror device. This method allows to create hydrogels with areas of different stiffnesses and hydrogels with precise stiffness gradients. The mechanical properties of the resulting hydrogels have been characterised using force indentation with atomic force microscopy, which demonstrated the efficiency to spatially pattern the elastic modulus of GelMA according to the photomask or the projected pattern. (1)

In addition to pattern mechanical properties, it is interesting to include a dynamic aspect to cell-laden biomaterials, since native ECM is constantly reshaped by cells. Composite hydrogels are developed to bring different combinations of structures and properties to a scaffold by using different types and sources of materials. We have combined GelMA with biocompatible supramolecular fibers made of a small self-assembling sugar-derived molecule (*N*-heptyl-D-galactonamide, GalC7). The GalC7 fibers were directly grown in the GelMA through a thermal process, and it was shown that the presence of the fibrous network increased the Young’s modulus of GelMA. Due to the non-covalent interactions that govern the self-assembly, these fibers were observed to dissolve over time, leading to a dynamic softening of the composite gels. Cardiac fibroblast cells were successfully encapsulated into composite gels for 7 days, showing excellent biocompatibility and fibroblasts extending in an elongated morphology, most likely in the channels left by the fibers after their degradation. These novel composite hydrogels present unique properties and could be used as tools to study biological processes such as fibrosis, vascularization and invasion. (2)

1) Chalard, Malmström, et al. Frontiers in Cell and Developmental Biology 2022, 10.

2) Chalard, Malmström, et al. BioMaterials Advances, 2024, accepted

Biomaterial Surfaces & Interfaces
Room Naupaka Salon 5 - Session BI1-TuM

Biomaterials/Interfaces - Biointeractions

Moderator: Kaori Sugihara, Institute of Industrial Science, the University of Tokyo

9:00am **BI1-TuM-4 Supercritical Angle Raman Microscopy (SAR-M): A Versatile Tool to Study Molecular Conformations at Surfaces on the Example of Amyloid and α-Synuclein Proteins***, N. Münch, S. Das,* ***Stefan Seeger***, University of Zurich, Switzerland

Supercritical Angle Raman Microscopy (SAR-M) emerges as a transformative technique for the in-depth study of molecular conformations at surfaces, providing unparalleled spatial resolution and sensitivity. This presentation explores the application of SAR-M to investigate the structural dynamics of amyloid and synuclein proteins, which are pivotal in neurodegenerative diseases such as Alzheimer's and Parkinson's. Utilizing the unique capabilities of SAR-M, we demonstrate its proficiency in capturing subtle conformational changes and aggregations of these proteins at the nanoscale, which are critical to understanding their pathological roles as well as the role of ions like Calcium.

Amyloid and synuclein proteins are known for their propensity to misfold and aggregate, forming insoluble fibrils that are toxic to neuronal cells. Traditional microscopy techniques often fall short in providing the necessary resolution and chemical specificity to study these proteins' surface interactions and early aggregation stages. SAR-M overcomes these limitations by exploiting the supercritical angle fluorescence to enhance Raman scattering signals, thereby achieving superior surface sensitivity.

Through a series of experiments, we detail the conformational mapping of amyloid-beta peptides and alpha-synuclein at different aggregation stages. The results reveal distinct molecular signatures and structural transitions, offering new insights into the mechanisms driving protein misfolding and aggregation. Additionally, SAR-M's capability to monitor these processes in real-time opens avenues for investigating the effects of potential therapeutic agents aimed at inhibiting or reversing protein aggregation.

Serrano D, Seeger S, Light: Science and Applications (2017) 6, e17066

Dubois A, Serrano D, Zhang X, Seeger S, Analytical Chemistry (2020) 4963

Münch NS, Das S, Seeger S, PCCP (2024), in press

9:20am **BI1-TuM-5 Biomimetic Leaf Surfaces as a Platform Technology to Study Bio-Interactions***,* ***Volker Nock****,* University of Cantebury, New Zealand*; S. Sale,* University of Canterbury, New Zealand*; A. Garrill,* University of Cantebury, New Zealand*; M. Bernach,* University of Cantebury, New Zealand, Germany*; M. Remus-Emsermann,* Freie Universität Berlin, Germany **INVITED**

Spatial and temporal variability of leave surfaces modulates plant-microbe and microbe-microbe interactions, creating diverse microenvironments for microbial colonizers such as bacteria and fungi. Mimicking leaf complexity on artificial surfaces greatly aids in the study of microorganisms residing on plant leaf surfaces [1]. Over the years, a number of surrogate surfaces aiming to replicate leaf surface topography have been proposed, ranging from simple nutrient agars to complex casts [1]. These surrogate surfaces are often used to deconstruct leaf surfaces into individual aspects, as this enables bio-interactions to be studied in separation [2].

In this paper I will discuss ongoing efforts to develop biomimetic leaf surfaces as a platform technology to study bio-interactions. In particular, I will focus on work related to bacterial colonization [2-4] and invasion by pathogenic rusts [6]. To date, this has involved *Arabidopsis thaliana* [2,3], as well as wheat, poplar, eucalyptus and mānuka mimics [5]. Incorporating properties such as leaf topography or hydrophobicity, these mimics all aim to promote colonizer survival in the absence of a living plant host. Characterizing agarose, polydimethylsiloxane (PDMS) and gelatin, we have determined PDMS to be one of the most suitable materials for leaf replicas [6]. Diffusion of water and nutrients to the surface of PDMS can be optimized by addition of fillers [7]. Increasing permeability, we have been able to demonstrate the possibility of delivering fructose to the surface, thus allowing division and distribution of bacteria to be affected [2]. Such leaf replicas have since also enabled us to culture in-vivo biotrophic rusts, normally considered “un-culturable” on artificial substrates due to the need for a living host [5], as well as helped to demonstrate that RNAi can be used to inhibit infections by these rusts [8].

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2. Bernach, M., PhD Thesis. 2024, University of Canterbury: Christchurch.
3. Soffe, R., et al., Sci. Rep. 9:14420, 2019.
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Biomaterial Surfaces & Interfaces
Room Naupaka Salon 5 - Session BI2-TuM

Biomaterials/Interfaces - Biosensing

Moderator: Volker Nock, University of Cantebury

10:20am **BI2-TuM-8 Mechanochromic Polymer, Polydiacetylene, for Force-, Bio-Sensing Applications***,* ***Kaori Sugihara****,* Institute of Industrial Science, the University of Tokyo, Japan **INVITED**

The forces around us, such as grip forces, loads on buildings and machines, and friction, are closely related to our health and safety. While technologies exist to measure such forces, there are still many types of forces that cannot be measured with existing technologies, such as molecular forces at nanoscale or the detection of curved or anisotropic forces. Mechanochromic materials are expected to play a pivotal role in these niches. In my talk, I will introduce the mechanism and applications of a mechanochromic lipid polymer called polydiacetylene towards biosensing.[1-2]

References

1. Juhasz, L.; Ortuso, R. D.; Sugihara, K., Quantitative and Anisotropic Mechanochromism of Polydiacetylene at Nanoscale. *Nano Lett* **2021,** *21* (1), 543-549.
1. Chen, J. L.; Zheng, J. L.; Hou, Y. G.; Sugihara, K., Colorimetric response in polydiacetylene at the single domain level using hyperspectral microscopy. *Chem Commun* **2023,** *59* (25), 3743-3746.

11:00am **BI2-TuM-10 Inspired by Nature: Next-Gen Multiplex Biosensing with Biomimetic Surfaces***,* ***Saimon Moraes Silva****,* 1/6 Patterson Street, Bonbeach, Australia **INVITED**

A major issue faced by electrochemical surfaces that need to function in biological fluids remains the biofouling of electrode surfaces. In this presentation, I will demonstrate how lubricin (LUB) can mitigate the biofouling issue and enable the development of biosensors that function in unprocessed whole blood. LUB is a cytoprotective glycoprotein present in synovial fluids and coating cartilage surfaces in articular joints.[1] It displays a distinguishing chemistry, conformational and molecular structure, and also the ability to self-assemble in a well-organized manner on substrates of different materials.[2,3] When attached to a conductive surface, LUB presents the capability of preventing biofouling and at the same time allowing good electrochemistry with the advantage of a simple and one-step coating preparation.[4] This makes LUB an interesting surface coating for applications such as bionic implants and electrochemical biosensors. In this presentation, I highlight both recent technological advances associated with the LUB coatings for use in electroactive surfaces and a number of recent advances toward point-of-care diagnostics enabled by this unique biomimetic surface coating.

References

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[4] M. J. Russo, M. Y. Han, A. F. Quigley, R. M. I. Kapsa, S. E. Moulton, E. Doeven, R. Guijt, S. M. Silva, G. W. Greene, Electrochimica Acta 2020, 333.

11:40am **BI2-TuM-12 Polyaniline-Gold Nanocomposite as an Electrode Material for Supercapacitor and Escherichia Coli Detection***,* ***Md Zaved Hossain Khan****,* Jashore University of Science and Technology, Bangladesh

The present work is focused on detection and quantification of low-density E. Coli using a new supercapacitor-based biosensor. Herein, gold nanoparticles (AuNPs) doped pseudo capacitive PANI-PS composite has been synthesized by in situ oxidative deposition of PANI-ES in the presence

of AuNPs in aqueous H2SO4. The novel nanocomposite AuNPs@PANI-PS exhibits excellent supercapacitor performance and bio-electrochemical sensing of E. Coli, which is only possible for chronoamperometry deposition respective charging event on electrode surface. In addition, AuNPs@PANI-PS electrode shows high specific capacitance (812.96 F/g, with 2.5 mA/g, current density) and 207.43 Wh/kg energy density respective 6.05 KW/kg power density. In E. Coli detection, AuNPs@PANI-PS based sensor can exhibit a wide linear range of 10-108 CFU/ml with a limit of detection of 1.0 CFU/ml. Except laboratory strain, we also detect it in urine medium. The proposed whole cell biosensor provides high selectivity for the detection of E. Coli bacteria in the presence of E. Coli DH5-α, E. Coli ATCC, S. Typhi DMS_A1, P. Aeruginosa, S. Flexneri, and others. Finally, the smartphone-based application of this biosensor showed excellent performance. Therefore, the proposed composite can serve as an effective material in supercapacitor and the monitoring of E. Coli

Biomaterial Surfaces & Interfaces

Room Naupaka Salon 1-3 - Session BI-MoP

Biomaterial Surfaces & Interfaces Poster Session

BI-MoP-1 Fabrication of Hydrogel-Based Optical Biosensor for Smart Intraocular Lens, ***Soongeun Kwon**, Y. Eom, H. Choi, J. Ahn, S. Park, H. Lim, G. Kim, K. Choi, J. Lee,* Korea Institute of Machinery and Materials, Republic of Korea

Due to the high biocompatibility, facile chemical modification and excellent responsiveness, hydrogel materials have received great deal of attention as wearable or implantable biosensor substrates. To fabricate a hydrogel-based biosensor, a stable bond at the interface of hydrogel and a functional sensing material is essential. In this study, we demonstrated fabrication and application of hydrogel-based optical sensor with a biocompatible micro-grating pattern for implantable medical devices.

To fabricate a functional micro-grating pattern, photolithographic patterning of a photoresist (PR) was performed to define the micro-scale line and spacing pattern. Gold (Au) nanoparticles spin-coated on the PR pattern were patterned by ligand exchange and lift-off process, resulting in an Au micro-grating pattern on a silicon (Si) wafer. The as-fabricated Au micro-grating pattern showed a rabbit ear morphology by controlling the thickness of the PR pattern. Subsequently, molding of a hydrogel precursor into the Au micro-grating pattern on a Si wafer was conducted to transfer the Au micro-grating pattern to the target hydrogel substrate.

The rabbit ear morphology and porous structure of the Au pattern enabled large interfacial contact area between hydrogel precursor and Au nanoparticles, resulting in stable bonding at the interface of Au micro-grating pattern and hydrogel substrate. Due to the biocompatibility of Au and hydrogel, this hydrogel-based biosensor can be used as for implantable medical devices.

As a case study, we demonstrated the application of hydrogel-based optical sensor composed of Au micro-grating pattern for smart intraocular lens (IOL). A pH-responsive hydrogel sensor with Au grating pattern was attached to an IOL to measure the micro-displacement of reactive hydrogel in response to pH changes by optical Moiré pattern detection. With the optical Moiré pattern detection scheme, the proposed hydrogel-based biosensor provides novel implantable optical sensor without external battery, highlightening its potential as a versatile tool for detecting various disease-specific biomarkers.

BI-MoP-2 Correlative Microscopy Without the Instrument Manufacturer; Using Computer-Readable Fiducial Markers to Navigate Specimens Irrespective of Who Made the Sample Stage, ***Peter Cumpson,*** La Trobe University, Australia

In the diverse field of microscopy, researchers often face challenges in correlating data across different instruments, each with proprietary hardware and software. This work introduces a novel, manufacturer-agnostic solution for correlative microscopy using computer-readable fiducial markers, facilitating seamless navigation and analysis across various microscopy platforms.

Our approach employs laser-etched fiducial markers on sample holders, enabling precise localisation of sample features. This methodology eliminates the need for instrument-specific solutions, significantly enhancing workflow efficiency and accuracy.

We have demonstrated the effectiveness of our system across multiple microscopy techniques, including Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Energy Dispersive X-ray Spectroscopy (EDX), X-ray Photoelectron Spectroscopy (XPS), and Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS). Our results indicate that this "GPS map for microscopy" not only improves the precision of correlative microscopy but also significantly reduces the time and costs associated with manual sample alignment and calibration.

In collaboration with the National Physical Laboratory (NPL) and University of Durham in the UK we have begun a project to demonstrate and verify the accuracy of this technique. This model considers various scales and imaging modalities, ensuring traceable measurement accuracy and enhancing the reliability of our method.

Our system offers significant advantages for a wide range of applications, from material science and battery research to biomedical and pharmaceutical studies. By enabling precise and consistent navigation across different microscopes, we facilitate interdisciplinary collaboration and accelerate scientific discoveries.

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