Biomaterial Interfaces
Room 321 - Session BI1-TuM

Biomaterials and Nanomaterials Fabrication I

Moderators: Prof. Joe Baio, Oregon State University, **Prof. Sapun Parekh**, University of Texas at Austin

8:00am **BI1-TuM-1 Engineering the Human Sense of Touch as the Finger-Object Interface*, Charles Dhong,*** University of Delaware **INVITED**

The human sense of touch is a basic sensory experience, and for those who are visually impaired, a critical source of information. Technologies that interface with the sense of touch or "haptics" have seen progress over the years, but remain limited in the variety of sensations that these devices can reproduce and are nowhere near the the ability to recreate everyday sensations, especially when we compare these haptic technologies to vision or sound.

In this talk, we will show how the mechanical forces generated at the finger-object interface through adhesion and friction phenomena can be leveraged to control, or study, the human sense of touch. Mechanical forces generated at this interface give rise to tactile sensations and ultimately fine touch perception. Manipulating this mechanical interface through surface chemistry, polymer chemistry, and thin-film mechanics can give rise to new kinds of haptic devices while also enabling fundamental investigations into the perception of touch. We will end this talk by giving examples of how advances in the finger-object interface can enable widespread applications, from new insights into sensory neuroscience, to new accessibility technologies, and to medical diagnostics.

8:30am **BI1-TuM-3 Curvature-Programmed Polymer Interfaces via Condensed Droplet Polymerization*, Rong Yang,*** Cornell University

Polymer interfaces with micro- and nanoscale convex topographies offer powerful routes to control optical response, imaging, sensing, and biointerfacial interactions. However, conventional lithography and self-assembly approaches often face tradeoffs among scalability, geometric tunability, and fabrication complexity. Here, we introduce condensed droplet polymerization (CDP), a one-step, template-free strategy in which condensed monomer droplets serve as nanoscale reactors to generate polymeric micro- and nanodome arrays with programmable size, curvature, and surface coverage. To make CDP predictive rather than empirical, we develop a theoretical framework that integrates monomer condensation, polymerization kinetics, droplet evaporation, and geometric arguments. This model rationalizes dome height and radius through the measurable droplet base radius, enabling accurate prediction of final dome geometry from synthesis conditions and monomer reactivity despite the stochastic nature of condensation. The resulting curvature-programmed interfaces exhibit distinct optical functions, including light focusing and magnification, with potential utility for high-resolution visualization of subwavelength features and biological specimens. As a biointerface demonstration, biphilic microdome arrays fabricated from poly(2-hydroxyethyl methacrylate) reduce *Pseudomonas aeruginosa* colonization without changing macroscopic wettability, suggesting a curvature-driven antifouling mechanism. Early evidence further supports its capability to program immune cell functions. Together, CDP and the accompanying predictive model establish a scalable platform for designing polymer thin-film architectures with controlled curvature. This approach provides new opportunities for morphology-by-design in optical, sensing, and biointerfacial applications

8:45am **BI1-TuM-4 RF Pulsed Plasma Modified Composite Scaffold for Enhanced Anti-Microbial Activity and Accelerated Wound Healing*, Ajinkya Mahadev Trimukhe,*** University of Milan Bicocca, Italy*; Jose Savio Melo,* Bhabha Atomic Research Centre, India*; Deepa Chaturvedi, Ratnesh Jain, Prajakta Dandekar, Rajendrasing Deshmukh,* Institute of Chemical Technology, India

This study entails the successful synthesis of a biodegradable microporous agarose-chitosan composite scaffold and modifying its surface with diphenyldiselenide (DPDSe), by using low-pressure RF pulsed plasma for enhanced wound-healing applications. The scaffolds' synthesis composition was optimized at a 3:1 agarose-to-chitosan ratio and 4% polymer concentration. The optimized RF plasma treatment parameters for depositing DPDSe on the scaffold surface were at a pulse rate of $5_{ON}/15_{OFF}$ (ms) for 80 minutes. The plasma-modified scaffold surfaces demonstrated superior antibacterial activity against Gram-positive bacteria *S. aureus* and *S. epidermidis*, achieving inhibition zones up to 24 mm and 26 mm, respectively, while maintaining excellent biocompatibility, with 91.9% and 88.6% cell viability for HaCaT and HadF cells, respectively. Surface characterization revealed enhanced hydrophilicity, with contact angles decreasing from 89° to 33°, and from XPS analysis, it was observed that there was increased oxygen content from 19.82% to 21.87%, and successful selenium deposition at an atomic concentration of 1.01%. *In vivo* studies using albino Wistar rats demonstrated accelerated wound healing, with plasma-modified scaffolds achieving 100% wound closure by day 14, compared with 16 days for untreated scaffolds, accompanied by enhanced collagen synthesis, evidenced by a hydroxyproline content of 5.96 µg/mL. The selenium-modified scaffolds showed comparable efficacy to standard Betadine treatment while offering practical advantages as solid dressing materials, making them promising alternatives for treating challenging wounds.

9:00am **BI1-TuM-5 Engineering Curvature-Controlled Polymer Dome Biointerfaces via Condensed Droplet Polymerization*, Haobo Xu,*** *Rong Yang,* Cornell University

Surface-attached dome morphologies are ubiquitous in nature but remain difficult to reproduce synthetically due to limited control over geometric parameters such as curvature. Here we introduce condensed droplet polymerization (CDP), a synthesis strategy that leverages condensed monomer microdroplets as discrete microreactors to produce surface-attached polymer dome arrays with precisely tunable geometry. The potential of CDP for functional interface design is demonstrated in two contexts. Inspired by dome-shaped morphologies on crustacean shells, we investigate antifouling behavior and identify an optimal intermediate dome size (~10 µm) with targeted curvature that significantly suppresses *Pseudomonas aeruginosa* attachment despite a globally hydrophobic surface. In addition, sub-micron dome arrays significantly increase extracellular vesicle yield from M1-polarized murine macrophages (J774A.1), suggesting that curvature-defined biointerfaces can regulate plasma membrane dynamics, particularly the inward budding process associated with the endocytic pathway, thereby promoting the subsequent production and release of extracellular vesicles. These results establish CDP as a versatile platform for engineering curvature-controlled interfaces for antifouling materials and cell-regulating biomaterials.

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