Biomaterials Plenary Session
Room: 22 - Session BP-SuA

Plenary - Engineering a Paradigm Shift in Control of Microbes and Fouling: In Honor of Michael Grunze's 70th Birthday
Moderator: Axel Rosenhahn, Ruhr-University Bochum, Germany

3:00pm **BP-SuA1 Non-toxic Surfaces which Prevent Biofouling:Quo Vadis?**, ***Michael Grunze***, Karlsruhe Institute of Technology (KIT), Germany **INVITED**

Biofouling, i.e. the settlement and colonization of bacteria and spores on surfaces is a major economic and environmental problem. Besides the obvious problems which biofouling causes in the clinical environment, biofouling is a serious problem also in food processing, aquacultures, shipping, underwater structures and ship hulls, heat exchangers, and buildings in tropical environments. The common—but environmentally extremely problematic—way to deal with biofouling is to incorporate heavy metals and/or biocides to kill the colonizing organisms. Hence, there is an urgent need to develop environmental benign stable and long lasting coatings to prevent biofouling.

The biofouling environment consists of multiple and often cooperatively interacting species of various sizes. Significant differences in the initial settlement behavior of bacteria, spores, larvae, and diatoms are observed on different chemical surface compositions, but the continuous deposition of dissolved macromolecules and polymers on "inert chemistries" leads to a "conditioning film" which soon renders any chemical modification of the surface ineffective. Topographic structures on surfaces change the macroscopic properties such as their wetting behavior, but also have a pronounced effect on how single cells and organisms attach, settle, and proliferate on the substrate. Both the enhancement of settlement, such as in cell cultures, but also the suppression of settlement can be the outcome of surface structuring. Promising are slippery liquid-infused porous surfaces (SLIPSs) which have been reported for their remarkable initial antifouling properties. However, their long-term stability against fouling is compromised by unavoidable defects in the SLIPS surface, and the slow deposition of a conditioning film.

In this presentation, I discuss if present research and development approaches are successful in creating lasting non-toxic non-fouling coatings for artificial surfaces. I will outline the different concepts to fouling prevention, and the challenges and technical difficulties encountered to realize long term stability and efficiency against fouling.

3:40pm **BP-SuA3 Engineering Serendipity: High-throughput Discovery of Materials that Resist Bacterial Attachment**, ***Morgan Alexander***, The University of Nottingham, UK **INVITED**

Tackling medical device centred infection is an important part of meeting the global challenge of antimicrobial resistance. We focus on materials that resist bacterial attachment and biofilm formation rather than kill the cells, since it is anticipated that the selective pressure to develop antimicrobial resistance will be lower. High throughput screening has been used to discover a novel class of polymers with resistance to bacterial attachment and subsequent biofilm formation. [Hook et al. Nat.Biotech. 2012, Adv.Mats. 2013] In order to rationally design devices for medical application and others where biofilm formation is a challenge, we are developing a fundamental understanding of the processes involved in the interaction of bacterial cells with our lead materials.

Physicochemical descriptions of the surfaces have been found insufficient to predict bacterial attachment across diverse chemistries included in large polymer libraries, and therefore cannot offer an explanation of the controlling phenomena. Whilst perhaps disappointing for the physical sciences, the life sciences are replete with information on how bacteria respond to their local environment, with motility being one of the most readily observed processes. Microorganisms cannot be approximated to inert objects as they possess surface responsive appendages such as flagella, which enable them to swim, pili that confer twitching motility and fimbriae that mediate surface attachment. These in turn are coupled to sophisticated signal transduction mechanisms that facilitate integration of multiple local environmental parameters at both single cell and population levels. Many of these sensory systems are postulated to contribute to surface sensing.

We believe that bacterial decision-making is key to determining whether a surface is colonised or not-specifically in the early stages of bacterial-surface interactions preceding biofilm formation. I will present results from our optical microscopy investigations of how individual bacterial cells respond to surfaces using a novel microscope that collects temporal 3D information on cell position and surface tracking simultaneously achieved using DIC, TIRF and TIR microscopy. I will combine this information with our early efforts to characterise bacterial footprints and compare with literature for *P. aeruginosa* where the exopolysaccharide Psl guides surface exploration [Zhao et al Nature 2013]. Elucidation of the sensory pathways by which bacteria decide not to form biofilms on some surfaces is expected to have wide ranging impact in all areas where biofilms form.

4:20pm **BP-SuA5 Say 'No' to Biofouling: Slippery Coatings that Resist Adhesion of Biological Matter**, ***Joanna Aizenberg***, Harvard University **INVITED**

Living organisms and biological substances are among the most difficult and persistent sources of surface fouling, particularly in medical and marine settings. The ability of organisms to adapt, move, cooperate, evolve on short timescales, and modify surfaces by secreting proteins and other molecules enables them to colonize even state-of-the-art antifouling coatings, and small surface defects can trigger protein aggregation and blood clotting. Attempts to combat these issues are further hindered by conflicting requirements at different size scales and across different species. Our recently developed concept of Slippery, Liquid-Infused Porous Surfaces (SLIPS) provides a defect-free, dynamic liquid interface that overcomes many of these problems at once. A single surface is able to prevent adhesion of a broad range of genetically diverse bacteria, including many pathogenic species that underlie widespread hospital-acquired infections, as well as marine algae. The same approach resists adhesion of proteins, cells, and blood, preventing clogging and thrombus formation inside medical tubing and catheters. At a larger scale, the slippery interface repels insects, barnacles and mussels, which slide off and actively avoid the coated surface. We are currently developing this strategy to solve longstanding fouling issues in a wide range of medical, marine, and other settings.

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