Biomaterial Interfaces
Room 321 - Session BI-MoA
The Future of Biointerface Science
Moderator: Prof. Dr. Tobias Weidner, Aarhus University, Denmark

4:00pm **BI-MoA-11 Interactions Between Marinobacter atlanticus and Heavy Metals***, **Sara Tuck**,* Naval Medical Research Command*; Maryssa Beasley, Rebecca Mickol,* U.S. Naval Research Laboratory*; Katherine Franz,* Duke University*; Kenan Fears,* U.S. Naval Research Laboratory

Marine bacteria have evolved mechanisms for the regulation of essential heavy metal ions (e.g., copper, zinc, cobalt). Understanding the interplay between these ions and marine bacteria is relevant to a variety of applications, including the development of antifouling coatings and materials and the capture and sensing of metal ions in seawater. Here we investigate the interactions between *Marinobacter atlanticus* and heavy metals commonly found in natural environments at trace levels. Further, *M. atlanticus* can produce small amounts of electricity and this ability is affected by labile metal ion concentration and can influence mineral cycling. We hypothesized that *M. atlanticus* may be a promising candidate for applications in heavy metal remediation or as a biosensor for heavy metal contamination. We utilized broth microdilution assays to expose *M. atlanticus* to a concentration range of essential and non-essential metal ions. *M. atlanticus* demonstrated a profound ability to grow in the presence of metal concentrations that significantly exceed those found in native environments. In metal depletion assays, where the ability of *M. atlanticus* to remove metal ions from solution was assessed, we found that this bacterium exhibited a marginal ability to reduce metal concentrations, with cadmium being the only heavy metal whose uptake significantly increased throughout a 72-hour evaluation period. Our results suggest *M. atlanticus* has limited use for bioremediation but could be used for biosensing.

4:15pm **BI-MoA-12 Addressing Agricultural Challenges Through Biomimetic Surfaces: Reframing Foliar Fungal Disease as a Biointerface Problem***, **River Pachulicz**, Bryan Coad,* Adelaide University, Australia

Food security and agricultural economies depend on the continued production of grain crops, including barley, wheat and oats. Foliar fungal diseases pose a major threat to grains production worldwide, and solutions to reduce their incidence heavily rely on broadacre fungicide applications after disease occurs. This can be costly, environmentally harmful and eventually promote the emergence of chemically resistant pathogens. Prophylactic strategies to prevent fungal disease occurrence are scarce, but a shared bottleneck to fungal disease progression may a key target for intervention: the fungal pathogen must detect and successfully recognise the host’s surface. This initial point of contact in plant-fungi interactions can hence be reframed as a biointerfaces problem that materials science can address.

The cuticle is a waxy bio-composite that coats the surface of leaves and is comprised of a cutin matrix that is embedded and/or coated with cuticular waxes, long chain aliphatic compounds that display an extensive range of carbon chain lengths and functional groups. Physiologically, the cuticle plays vital roles in water retention and physical defence against disease, however; increasing evidence has demonstrated that some cuticular waxes can signal recognition to pathogenic fungi to promote infection. The complexity of these plant-fungi interactions hence make them challenging to study and require model systems that can assess the effect of individual surface variables on fungal development.

To address this, we propose the development of a biomimetic model system using fabricated wax films to replicate native leaf chemistries on inert substrates. Using fabrication techniques including spin-coating to generate thin films that can be characterised using a suite of analytical techniques to assess their hydrophobicity, thickness, uniformity and morphology, precise tuning of surface physicochemical properties can be achieved. Individual surface parameters can then be disentangled and systematically assessed in the context of fungal development to identify key virulence traits at the leaf surface.

4:30pm **BI-MoA-13 Scaling Biomaterials Manufacturing: Lessons from the Paper Industry***, **Sandro Zier**,* University of Maine

Biomaterials are increasingly being explored as sustainable alternatives to petroleum-derived materials, but many systems that perform well at laboratory scale remain difficult to manufacture reliably at industrial scale. One reason for this disconnect is that biomaterial structure and function are strongly influenced by the physical conditions present during assembly, including flow, transport, dewatering, and drying conditions that differ substantially between laboratory and industrial environments. This talk presents a framework for designing biomaterials with formation conditions and manufacturing environments considered from the outset instead of introducing process constraints only after laboratory optimization. Using papermaking and related large-scale bio-based manufacturing systems as examples, the presentation examines how process-dependent assembly governs interfacial structure development across systems including microfibrillated cellulose, protein-based materials, biofilms, and mycelium composites. Differences between benchtop and industrial processing are discussed in terms of flow behavior, transport limitations, shear history, and consolidation dynamics, demonstrating that scale-dependent physical regimes can produce fundamentally different structures and functional behavior. The talk further outlines a process-integrated framework in which material selection, structure formation, and manufacturing constraints are treated as interconnected design variables. Finally, future needs in process-relevant characterization, multiscale modeling, and experimental tools capable of probing biomaterial formation under realistic manufacturing conditions are discussed. Incorporating formation pathways into biomaterials research may improve reproducibility and help bridge the gap between laboratory discovery and industrial implementation.

4:45pm **BI-MoA-14 Extreme Copper Tolerance and Genomic Adaptation in Early-Stage Marine Biofilms***, **Kailey Richard**,* U.S. Naval Research Laboratory*; Sara Tuck,* Naval Medical Research Command*; Sophie Colston, Maryssa Beasley, William Hervey,* U.S. Naval Research Laboratory*; Kevin Le,* NOVA Research, Inc.*; Sean Brown,* U.S. Naval Research Laboratory*; Katherine Franz,* Duke University*; Kenan Fears,* U.S. Naval Research Laboratory

Biofouling, the accumulation of unwanted organisms on submerged assets, presents an ongoing challenge within the maritime industry. Conventional methods to inhibit growth rely heavily on the application of copper-laden (≤75% copper compounds) antifouling coatings. However, the efficacy of these coatings is declining due to the broad emergence of copper-tolerant species. Here we investigated the mechanisms underlying this decline in antifouling performance. Polyvinyl chloride (PVC) panels coated with a commercial copper ablative paint were deployed in the Chesapeake Bay to collect early-stage biofilms; uncoated PVC panels were deployed as an inert control group. Community profiles of the harvested biofilms were obtained via 16S amplicon sequencing of the V4-V5 region. To elucidate genomics information about specific bacteria, primary bacterial colonizers were isolated on marine agar plates and identified through 16S amplicon sequencing and whole genome sequencing (WGS). The isolates were subsequently assessed for copper tolerance using copper sulfate ($CuSO_4$) in both marine agar and broth assays. While bacterial tolerance declined with increasing $CuSO_4$ concentrations on agar, tolerance was significantly greater in liquid media. We observed all isolates survived extreme concentrations, with minimum inhibitory concentrations (MIC) equal to or above 5 mM $CuSO_4$. Genomic annotation confirmed that this high phenotypic tolerance was driven by active genetic resistance mechanisms. Every isolate harbored at least three copper-related genes (e.g., *copA, cueO, copZ*), with highly adaptable species carrying a full spectrum of resistant genes. Ultimately, these findings highlight how the accumulation of metal resistance genes allows bacteria to colonize metal-rich surfaces, paving the way for subsequent macrofouling and coating failure.

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