Building Bioactivity into 'Slippery' Liquid-Infused Porous Surfaces

<u>*David M. Lynn*</u>*

Department of Chemical and Biological Engineering and Department of Chemistry,
University of Wisconsin—Madison, 1415 Engineering Drive, Madison, WI 53706, USA
E-mail: dlynn@engr.wisc.edu

The recent development of so-called 'slippery' liquid-infused porous surfaces (or 'SLIPS') offers new approaches to prevent biofouling on a range of commercial and industrial surfaces, including those of biomedical devices. Many different types of SLIPS, fabricated from a variety of different porous matrices and hydrophobic liquid oils, have been demonstrated to resist adhesion and colonization by microorganisms. However, while SLIPS are generally good at preventing fouling on surfaces to which they are applied, they are not perfect, and they can currently do little to prevent the proliferation of non-adherent (planktonic) organisms—*e.g.*, to stop them from colonizing other surfaces or prevent them from engaging in other behaviors, such as virulence factor production, that could lead to infection or associated burdens.

We recently reported an approach to the design of multi-functional, bioactive SLIPS that address these issues and expand the potential utility of slippery surfaces in antimicrobial contexts. Our approach is based on the incorporation and controlled release of small-molecule antimicrobial agents from hydrophobic porous polymer matrices used to host infused oil phases. Our studies reveal that SLIPS designed using nanoporous polymer multilayers, fabricated using covalent layer-by-layer assembly, can prevent short- and longer-term colonization and biofilm formation by four common fungal and bacterial pathogens (*Candida albicans*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus*), and that the polymer and oil phases comprising these materials can be exploited to load and sustain the release of triclosan, a model hydrophobic and broad-spectrum antimicrobial agent, into surrounding media. This approach both improves the inherent anti-fouling properties of these materials and endows them with the ability to efficiently kill planktonic pathogens.

The modular nature of this approach to materials design can be used to fabricate 'dual-action', bioactive SLIPS on complex surfaces, including the insides of flexible polymer tubing used to fabricate vascular and urinary catheters. This strategy has the potential to be general; we anticipate that these materials, strategies, and concepts will enable new designs of bioactive slippery surfaces with improved anti-fouling properties, and open the door to new applications of slippery liquid-infused materials that host or promote the release of a variety of other types of bioactive agents. Recent efforts to apply these approaches and principles to the design of anti-fouling surfaces that can attenuate virulence phenotypes in non-adherent bacteria through the release of small-molecule inhibitors of bacterial communication (*i.e.*, quorum sensing inhibitors) will also be discussed.