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Preface: Forum on Advances in Biocidal Materials and Interfaces

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This issue of *ACS Applied Materials & Interfaces* contains a forum on the topic of recent advances in the field of materials and interfaces that exert activity against a variety of pathogenic microorganisms, including a broad spectrum of bacteria, fungi, and even viruses. According to the World Health Organization, the rapid rise in antimicrobial resistance, which is further compounded by the recalcitrant decline in the number of new antimicrobial drugs approved each year, has given rise to a critically urgent public health crisis.[1]

As we publish this forum, the current worldwide public health crisis of COVID19 has highlighted the particularly emergent need for materials that inactivate enveloped viruses on contact. Although the majority of papers on biocidal materials tend to focus on antibiotic drug-resistant bacteria (for good reason), renewed focus on enveloped viruses such as SARS-CoV2 is expected to increase rapidly in the near future. Much of the literature on antibacterial materials and interfaces has examined a mechanism of membrane disruption. It will be interesting in the future to discover the extent to which such knowledge may (or may not) be transferrable to the disruption of the lipid bilayer in enveloped viruses. Some precedent for such a concept is found in the early work of Klibanov.[2] Although it remains unknown at present, the prospect of applying these technologies, or similar, against the spread of SARS-CoV2 is clearly a high priority. In addition, the secondary bacterial infections of the lungs (pneumonia) that occur in critically ill COVID19 patients also highlight the paramount importance of biocidal coatings in the hospital setting.

In this forum, you will find a wide variety of new ideas, methods, and developments in the area of active materials that can serve to self-disinfect materials and surfaces of interest. A review by Mitra et al. examines the high efficacy of various copper-based antimicrobial coatings in the clinical setting, drawing contrast with silver-based approaches. Lara and co-workers demonstrate the utility of silver nanoparticles in preventing fungal biofilms on clinically relevant silicone elastomer materials. Ghosh et al. present their work on novel antibacterial and antiviral coatings that feature covalently linked quaternary ammonium groups. Volmer and co-authors report the effects of sub-micrometer roughness on bacterial adhesion. Krumm and co-workers highlight their efforts on antibacterial polyionenes that kill bacteria on contact. Zhang and co-workers showed a new approach to antibacterial microgels that contain catechols in conjuction with magnetic nanoparticles. Song and co-workers provide a perspective on choice of materials and strategies for designing antimicrobial surfaces.

The forum is rich with many other interesting and diverse approaches to biocidal materials. The breadth and depth of the work presented is stunning and timely. Rahman and co-workers revealed their current advances in a new class of antibacterial compounds derived from renewable resources, which display localized facially amphiphilic units in the side chains, resulting in remarkable antibacterial activity. Li and co-workers present biguanidine-based nanoparticles that effectively combat MRSA biofilms in vivo. The group including Schneider-Chaabane leveraged multifunctional polymers of itaconic acid to generate surface coatings with excellent stimuli-responsive antibacterial activity, resistance to biofouling, and high biocompatibility. Dalchand and colleagues present a spotlight on applications summarizing a wealth of fundamental experimental and theoretical studies on polycation interactions with model lipid bilayers. Guo et al. developed a new polymer platform based on rigid trisphenyl amino groups with pendant primary amine side chains. These assemble into nanoparticles with outstanding antibacterial activity and low cytotoxicity.Yuan et al. present an innovative study on hybrid materials comprised of photodynamic π-conjugated polymers and quantum dots as novel antibacterial agents. Chen and co-workers present so-called "cationic molecular umbrellas" that consist of a cationic dendron attached to a long hydrophobic alkyl tail, with excellent antibacterial potency and hemocompatibility. This new molecular design architecture generated a promising lead candidate with potent activity and relatively low hemolytic toxicity. Wang et al. present their novel strategy to use photothermally activated surfaces to trigger the ejection of bacteria. Zhou and co-workers present a minimalist strategy to develop membrane-disrupting antibacterial agents by a clever, pharmaceutically inspired design of small molecule scaffolds. Zhu et al. describe using a mannose presenting polymer coating to promote formation of a non-pathogenic biofilm to prevent pathogen film formation. Liu and co-workers describe superhydrophobic coatings with anticontact and antimicrobial properties. Finally, Scheberl and co-authors report a quantitative study of the antibacterial activity of a family of cationic conjugated polymers.

Special Issue: Advances in Biocidal Materials and Interfaces

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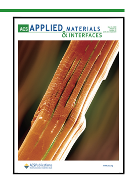

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Taken together, this collection of articles demonstrates the diverse multidisciplinary efforts underway in the rapidly expanding field of biocidal materials. Against the backdrop of urgency during the current worldwide public health crisis, we hope that these articles, and the vast swath of references therein, will provide a motivational driving force for scientists and engineers of diverse disciplines to devote their efforts toward such a critical field of work.

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Notes

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