Dimeric Copper and Zinc Metallosurfactants for Antimicrobial Coatings: Interplay of Bulk and Interfacial Properties

Ana Ivančić [1], Krunoslav Bojanić [1], Mirna Perkušić [2], Zhenxue Zhang [3], Katarina Marušić [1], Ana Franić [4], Tihana Dekanić [4], Maja Dutour Sikirić [1] and Darija Domazet Jurašin [1]

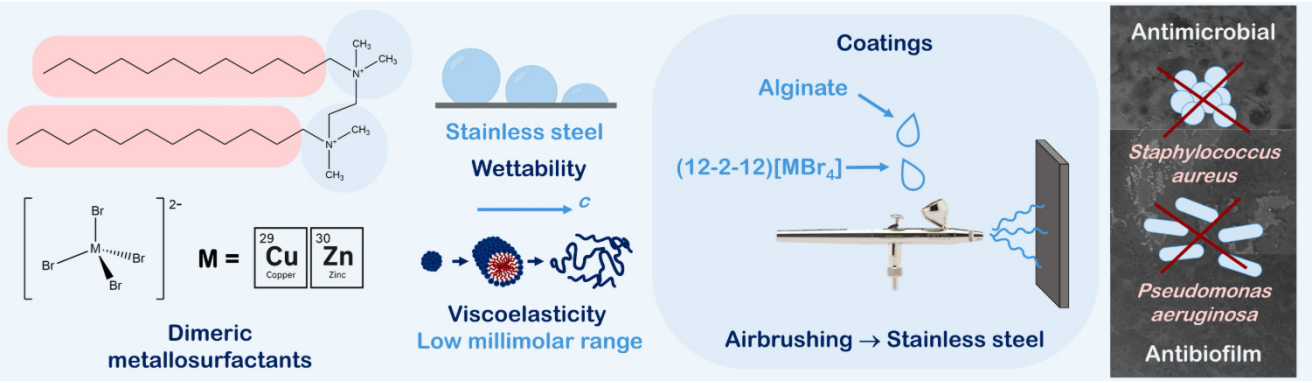
[1] Ruđer Bošković Institute, HR-10000 Zagreb, Croatia
[2] Faculty of Pharmacy and Biochemistry, University of Zagreb, HR-10000 Zagreb, Croatia
[3] University of Birmingham, Birmingham, B15 2TT, United Kingdom
[4] Faculty of Textile Technology, University of Zagreb, HR-10000 Zagreb, Croatia

aivancic@irb.hr

Metallosurfactants, surfactants that contain metal ions bound to the molecule itself or as part of complex counterions, show great potential for applications both in the solid state and in solution [1,2]. By incorporating metal ions with known antimicrobial properties, such as copper(II) [3] and zinc(II) [4], dual-action systems suitable for the development of multifunctional coatings can be designed.

In this work, building on the well-established physicochemical properties of the dimeric surfactant, bis(*N* , *N* -dimethyl- *N* -dodecyl)ethylene-1,2-diammonium dibromide (12-2-12) [5], (12-2-12)[$CuBr_4$] and (12-2-12)[$ZnBr_4$] were synthesized [1] and characterized, including contact angle on stainless steel (SS), and rheological measurements. To obtain antibacterial coatings, a concentrated metallosurfactant solution was spray-coated onto SS plates using an airbrush, while alginate was applied as the topmost layer to improve mechanical stability. Additionally, copper(II) oxide or zinc(II) oxide nanoparticles were incorporated to enhance antimicrobial properties. The resulting coatings were characterized by scanning electron microscopy (SEM), streaming potential measurements, and mechanical testing, while their antibiofilm activity was evaluated against two bacterial species, *Staphylococcus aureus* and *Pseudomonas aeruginosa* .

In comparison to the metal-free precursor, dimeric metallosurfactants exhibit a shifted onset of viscoelasticity and lower contact angles on stainless steel at the low millimolar range. The SEM images of the coating surfaces showed an island-like morphology, while peel-off and scratch tests confirmed good adhesion. Interestingly, the coatings have similar isoelectric points, irrespective of their composition. Antibacterial testing confirmed pronounced antibiofilm performance, while the presence of nanoparticles did not significantly affect the final antibacterial properties.



Graphical abstract

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Acknowledgements:
This work was financially supported by the European Union's Horizon-RIA project, Surface Transfer of Pathogens (STOP), Grant agreement ID: 101057961 and Croatian Science Foundation project IP-2024-05-3668, MSurf-n-SWIM.