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Nanomaterials for Antibiofilm Applications

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Extended Abstract

Biofilms are central to some of the most urgent global challenges across diverse fields of application, from medicine to industry to the environment and exert considerable economic and social impact. To combat biofilm growth on surfaces, chemical-based approaches using immobilization of antimicrobial agents, such as antibiotics or silver particles, can trigger antimicrobial resistance. Alternative, physical-based approaches (e.g. nanostructures) can be used, but their effects may not last due to initial adherent bacteria spreading laterally and masking surfaces within a couple of days. We have demonstrated that a multiscale surface structure can further delay biofilm formation but it is still not effective over longer periods of time. The innovation of lubricant impregnated surfaces (LIS) as surfaces slippery to liquids has been attracting significant interest in anti-icing, most recently, as a new anti-biofilm strategy. However, the potential loss of lubricant through repeated usage or shear remains a key limiting factor to wider adoption as a practical solution. In the present work, we report an antibiofilm surface strategy using liquid-like nanocoating where the risk of lubricant loss is removed. Our strategy overcomes the limitations of prior approaches, achieving sustained biofilm inhibition without triggering antimicrobial resistance. Experimental validation demonstrates the coating's long-term effectiveness, highlighting its potential for real-world applications in medical devices, water treatment, marine and other industrial systems. This work advances the frontier of antibiofilm technologies, offering a scalable, resistance-resistant platform to address biofilm-related challenges globally.