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Rechargable N-Halamine Nanoparticles for Antibacterial and Antifouling Applications

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Abstract : Biofilm formation is a serious problem in medical and industrial settings due to the increased resistance of these communities to killing compared to free-living bacteria. This has prompted the search for agents that can inhibit both bacterial growth and biofilm formation. In this study, N-halamine rechargeable nanoparticles (NPs) were synthesized by co-polymerization of the monomer methacryl amide and the cross-linker monomer N,N-methylene bisacryl amide, and were subsequently loaded with Cl+, using bleach. The chlorinated NPs exhibited remarkable stability to organic reagents. The antibacterial mechanism of the P(MAA-MBAA)-Cl NPs involved generation of reactive oxygen species (ROS) only upon exposure to organic media, but not upon incubation in water, suggesting a specific activation. Moreover, a unique interaction of the P(MAA-MBAA)-Cl NPs with Staphylococcus aureus bacteria but not with human cells was discovered, whereby these microorganisms were all specifically targeted and marked for destruction. Finally, in collaboration with Netafim Ltd. irrigation drippers containing the P(MAA-MBAA)-Cl were incubated in the field and were shown to prevent fouling on them for 5 months as opposed to the control drippers that exhibited substantial fouling. Further, the NPs offer recharging to the surface, thus providing long-lasting protection that does not exist in the products available today. Taken together, the results demonstrate the great potential of implementing the charged NPs in devices and surfaces to prevent bacterial growth.

Keywords : bacteria, biofilm, fouling, nanoparticles
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