A Self-Disinfecting Nanomaterial for Future Space Travel

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A big challenge of long term space travel and habitation is bacteria proliferation in the spacecraft and space station. Bacteria form threatening biofilms that jeopardize equipment and the health of astronauts. Strict quarantine, antibiotics coating, and cleaning procedures were ineffective in preventing biofilm contamination. In this study, I created nanomaterials that can inhibit bacterial growth without the use of water and cleaning chemicals. The antibacterial mechanisms of the nanomaterials were analyzed by comparing how polymer polarity affects bacterial growth. I hypothesized that polar nanopillar polymers can prevent bacteria growth, which may help explain the mechanisms of bacteria death. Nanopillars were fabricated on polar polymers, polymethyl methacrylate (PMMA) and polycarbonate (PC), and nonpolar polymers, cyclic olefin copolymer (COC) and high-density polyethylene (HPDE) via hot embossing nanoimprint lithography. Raman spectroscopy confirmed the stability of the polymeric films. Pseudomonas (PAO1) bacteria were incubated on each surface and biofilm growth was visualized with scanning electron microscopy. The colony forming units of PAO1 growth were measured. I discovered that polar nanopillar polymers significantly prevented bacteria growth compared to the control (67% to 83% decrease in bacteria on nanopillars) while nonpolar polymers did not prevent bacteria growth (20% to 30% increase in bacteria on nanopillars). The results suggest that electrostatic interactions between polar nanopillar surfaces and bacterial membrane proteins yield high antibacterial effects. This innovative nanomaterial could prevent biofilm buildup in microgravity environments and microbial contamination of spacecraft and Advanced Life Support (ALS) modules.

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