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Author: Ms. Madelyn Mettler
Montana State University, United States

PREVENTION OF BIOFILMS IN SPACECRAFT WATER SYSTEMS VIA MATERIAL COATINGS

Abstract

Biofilms are slimy communities of microorganisms, often attached to surfaces. The advent of space travel extended the reach of biofilms from Earth to the International Space Station and other spacecraft. Previously, biofilm formation in the ISS water recycle system has clogged valves, requiring the replacement of these parts and system redesign. Antibiofilm coatings offer one approach to mitigate biofilms in spacecraft water recycle systems. Combined with additional mitigation strategies like biocides, coatings could greatly reduce biofilm accumulation, resulting in cleaner water and improved spaceflight sustainability. This project seeks to determine biofilm reduction by several coatings against five microbes commonly isolated from the ISS wastewater tank. This project uniquely employs a five species biofilm featuring bacteria and a eukaryote, compared to historically researched single-species bacterial biofilms. The consortium consists of four bacteria: *Ralstonia insidiosa, Burkholderia contaminans, Methylobacterium organophilum*, and *Cupriavidus metallidurans*, as well as a filamentous fungus, *Lecythophora mutabilis*. Biofilms are grown in a normal gravity system (CDC biofilm reactor) with a medium designed to mimic the chemical composition and nutrient availability of the ISS wastewater during a biofilm clogging event. Further, while experiments occur at normal gravity, the organisms, medium and materials used closely match those found in situ on the ISS. Coatings are evaluated on Teflon and Inconel (a nickel-chromium alloy), two materials found in the ISS water system. The biofilms on uncoated coupons reach a density of about 8.5 log10CFU/cm2 (CFU: colony forming unit) after 7 days in continuous flow, largely dominated by *R. insidiosa*. Confocal and scanning electron microscopy reveal that the fungus not only contributes to much more biomass than its cell density suggests, but also that it acts as a scaffold for bacterial cell attachment. While the coatings tested result in similar total cell density at the end of the experiments, the species distribution varies between coatings. These preliminary results suggest that not all species contaminating the wastewater tank will be eliminated using the same strategy, and we may have to target which species to eliminate based on their interactions with the other members of the biofilms.