Paper ID: 65214
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IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Life and Physical Sciences under reduced Gravity (7)

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PREPARATION FOR AND PERFORMANCE OF A PSEUDOMONAS AERUGINOSA BIOFILM EXPERIMENT ON BOARD THE INTERNATIONAL SPACE STATION

Abstract

Biofilms are a problem on Earth given their ability to degrade the materials upon which they grow and due to their relevance to infections. Remarkably, 65% and 80% of infections and chronic diseases on Earth are associated with biofilms, respectively. In space, these problems' impact is higher because the crew's lives and mission success depend on nominal operation of mechanical systems. Furthermore, the isolated confined environment nature of spaceflight may increase the rates of disease transmission. In the case of the International Space Station (ISS), biofilms are an identified problem on the Environmental Control and Life Support System (ECLSS), namely on the water processor assembly (WPA). In late 2019, the Space Biofilms experiment launched towards ISS to (*i*) characterize the mass, thickness, morphology, and gene expression of biofilms formed in space with respect to matched Earth controls, (*ii*) interrogate the expression of antimicrobial resistance genes, and (*iii*) test novel materials as potential biofilm control strategies for future ECLSS components. For this, 288 bacterial samples were prepared prior to the launch of the Northrop Grumman CRS-12 mission from NASA's Wallops Flight Facility. The samples were integrated into the spaceflight hardware, BioServe's Fluid Processing Apparatus (FPA) packed in sets of eight in Group Activation Packs (GAP). Half of these samples were activated and terminated on orbit by NASA astronauts Jessica Meir and Christina Koch, while the remaining half were processed equivalently on Earth. The spaceflight bacterial samples of Space Biofilms returned on board SpaceX' CRS-19 Dragon spacecraft, in early 2020. We here describe the test campaign implemented to verify the experiment design and confirm it would enable us to achieve the project's scientific goals. This campaign ended with the Experiment Verification Test (EVT), from which we here present example morphology and transcriptomic results. We describe in detail the sample preparation prior to flight, including cleaning and sterilization of the coupons of six materials (SS316, passivated-SS316, lubricant impregnated surface, catheter-grade silicone with and without a nanotopography, and cellulose membrane), loading and integration of growth media, bacterial inoculum, fixative and preservative to enable experiment termination on orbit. Additionally, we describe the performance of the experiment on board the ISS, including crew activities, use of assets, temperature profile, and experiment timeline; all leading to a successful spaceflight experiment.

This material is based upon work supported by the National Aeronautics and Space Administration under Grant No. 80NSSC17K0036.