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

Author: Ms. Diana Pamela Flores Ayuso
University of Colorado Boulder, United States

Dr. Luis Zea
University of Colorado Boulder, United States

SPACE BIOFILMS – AN OVERVIEW OF THE MORPHOLOGY AND GENE EXPRESSION OF PSEUDOMONAS AERUGINOSA BIOFILMS GROWN ON BOARD THE INTERNATIONAL SPACE STATION

Abstract

Microorganisms' natural ability to live as organized multicellular communities – also known as biofilms – provides them with unique survival advantages. For instance, bacterial biofilms are protected against environmental stresses thanks to their extracellular matrix, which could contribute to persistent infections after treatment with antibiotics. Bacterial biofilms are also capable of strongly attaching to surfaces, where their metabolism byproducts could lead to surface material degradation. Furthermore, microgravity can alter biofilm behavior in unexpected ways, making the presence of biofilms in space a risk for both astronauts and spaceflight hardware. Despite the efforts to eliminate microorganism contamination from spacecrafts surfaces, it is impossible to prevent human-associated bacteria from eventually establishing biofilm surface colonization. Nevertheless, by understanding the changes that bacterial biofilms undergo in microgravity, it is possible to identify key differences and pathways that could be targeted to significantly reduce biofilm formation. The bacterial component of Space Biofilms project, performed at the International Space Station in early 2020, contributes to such understanding by characterizing the morphology and gene expression of bacterial biofilms formed in microgravity with respect to ground controls. *Pseudomonas aeruginosa* was used as model organism due to its relevance in biofilm studies and its ability to cause urinary tract infections as an opportunistic pathogen. Biofilm formation was characterized at one, two, and three days of incubation (37C) over six different materials. Materials included stainless steel 316, and passivated stainless steel 316 due to their relevance in spacecraft components; catheter grade silicone due to its medical relevance in hospital acquired infections; cellulose membrane to replicate the column and canopy structure previously reported in microgravity; and a lubricant impregnated surface and catheter grade silicone with direct laser interference patterning, both to test microtopographies as a potential biofilm control strategy. We here present an overview of the Space Biofilms bacterial morphology and transcriptomic results, including 3D images of the biofilms to represent the distinctive morphology observed in each material tested, and some of the key differences observed in biofilm thickness, mass, and surface area coverage. We also present the impact of the surface microtopographies in biofilm formation, the trends in gene expression variation and metabolic pathways enrichment across materials, incubation time, and gravitational conditions, and the effect of microgravity in antimicrobial gene expression.

The Space Biofilms project (bacterial side) is supported by the National Aeronautics and Space Administration under Grant No. 80NSSC17K0036.