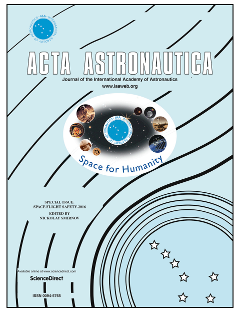

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DESIGN OF A SPACEFLIGHT BIOFILM EXPERIMENT

Luis Zea[1]*, Zeena Nisar[1], Phil Rubin[1], Marta Cortesão[2], Jiaqi Luo[3], Samantha A. McBride[4], Ralf Moeller[2], David Klaus[5], Daniel Müller[3], Kripa K. Varanasi[4], Frank Muecklich[3], Louis Stodieck[1*]

[1] BioServe Space Technologies, Aerospace Engineering Sciences Department, University of Colorado, Boulder, 80309 USA
[2] Institute of Aerospace Medicine, German Aerospace Center (DLR), Cologne, 51147 Germany
[3] Functional Materials, Department of Materials Science and Engineering, Saarland University, 66123 Germany
[4] Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA, 02139 USA
[5] Aerospace Engineering Sciences Department, University of Colorado, Boulder, 80309 USA

* Corresponding author: Luis.Zea@Colorado.edu

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Biofilm growth has been observed in Soviet/Russian (Salyuts and Mir), American (Skylab), and International (ISS) Space Stations, sometimes jeopardizing key equipment like spacesuits, water recycling units, radiators, and navigation windows. Biofilm formation also increases the risk of human illnesses and therefore needs to be well understood to enable safe, long-duration, human space missions. Here, the design of a NASA-supported biofilm in space project is reported. This new project aims to characterize biofilm inside the International Space Station in a controlled fashion, assessing changes in mass, thickness, and morphology. The space-based experiment also aims at elucidating the biomechanical and transcriptomic mechanisms involved in the formation of a "column-and-canopy" biofilm architecture that has previously been observed in space. To search for potential solutions, different materials and surface topologies will be used as the substrata for microbial growth. The adhesion of bacteria to surfaces and therefore the initial biofilm formation is strongly governed by topographical surface features of about the bacterial scale. Thus, using Direct Laser-Interference Patterning, some material coupons will have surface patterns with periodicities equal, above or below the size of bacteria. Additionally, a novel lubricant-impregnated surface will be assessed for potential Earth and spaceflight anti-biofilm applications. This paper describes the current experiment design including microbial strains and substrata materials and nanotopographies being considered, constraints and limitations that arise from performing experiments in space, and the next steps needed to mature the design to be spaceflight-ready.

Keywords: bacteria; fungi; *Pseudomonas aeruginosa*; *Penicillium Rubens*; Direct Laser-Interference Patterning (DLIP); lubricant-impregnated surface (LIS)

1. INTRODUCTION

1.1 Biofilms

Biofilms are formed by groups of organisms that are adhered to each other by self-synthesized extracellular polymeric substances, and are ubiquitous in industrial and natural environments [1]. The formation of biofilms increases the risk of pathogen transmission in food handling facilities, drinking water systems, and medical devices. Furthermore, biofilms can decrease the efficiency and lifetime of equipment such as heat exchangers, air and water recycling systems, etc. [1-2]. Biofilm bacteria and fungi tend to have an increased resistance to disinfectants, antibiotics, and environmental stresses – such as salt, oxidizers, and low pH – making it difficult to address the problems that arise from their formation [3-5]. In addition to the challenges that emerge from their formation on surfaces, biofilms play an important role in several human diseases and infections, including endocarditis (bacterial infection of cardiac tissue), cystitis (a urinary tract infection), and otitis media (an inflammatory disease of the middle ear) [3], to name a few.