HUMAN IN SPACE 2021 – APRIL 5-8 Moskow, Russia

Oral Presentation
Topic: Astrobiology, Space Biology and Space Biotechnology

Title: **Fighting microbial biofilms in space by ESA's upcoming space microbiology and material science experiment BIOFILMS**

Katharina Siems[1], Daniel Müller[2], Laurens Maertens[3,4], Rob Van Houdt[3], Rocco L. Mancinelli[5], Nicol Caplin[6], Jutta Krause[6], Rene Demets[6], Alessandra Tortora[7], Michael Laue[8], Frank Mücklich[2], Christine E. Hellweg[1] and Ralf Möller[1]

[1] Institute of Aerospace Medicine, German Aerospace Center (DLR), Cologne, Germany
[2] Department of Materials Science and Engineering, University of Saarland, Saarbrücken, Germany
[3] Microbiology Unit, Interdisciplinary Biosciences, Belgian Nuclear Research Centre (SCK CEN), Mol, Belgium
[4] Research Unit in Microorganisms Biology (URBM), Narilis Institute, University of Namur, Namur, Belgium
[5] NASA Ames Research Center / Bay Area Environmental Research Institute, CA, USA
[6] ESA, European Space Research and Technology Centre (ESTEC), Noordwijk, Netherlands
[7] Kayser Italia Srl, Livorno, Italy
[8] Robert-Koch-Institut, Berlin, Germany

Contact: katharina.siems[at]dlr.de

Long term human space missions require efficient strategies to sustain crew health and safety. This is why we need to develop improved spaceflight-suitable methods for microbiological monitoring and contamination control. Especially microbial biofilms are of concern in spaceflight because they can damage equipment by polymer deterioration, corrode metal and cause bio-fouling. Furthermore, biofilms can harbor pathogenic microorganisms that can cause infections which is unwanted, especially since it is known that the immune system of astronauts is impaired during spaceflight. Antimicrobial surfaces reduce the ability of microorganisms to form biofilms and can therefore be helpful in sustaining spaceship integrity as well as the astronaut's health. Metals such as silver, copper and their alloy are known to have antimicrobial properties. The introduction of antimicrobial surfaces for medical, pharmaceutical and industrial purposes has already shown a unique potential for reducing and preventing microbial contamination. However, their efficiency within the spaceflight context still has to be investigated in further detail:

The European Space Agency (ESA) selected project BIOFILMS (No. ILSRA-2014-054) will test the effect of tailor-made nanostructured copper-based surfaces on bacterial biofilm in an experiment aboard the International Space Station (ISS). BIOFILMS is an acronym that stands for “Biofilm Inhibition on Flight equipment and on board the ISS using microbiologically Lethal Metal Surfaces". In the project, three spaceflight relevant bacterial species will be tested: *Acinetobacter radioresistens, Cupriavidus metallidurans* and *Staphylococcus capitis.* Steel is going to be used as a refence surface for biofilm formation and the antimicrobial surfaces are copper-based. They differ in their antimicrobial activity based on chemical composition and/or geometric nanostructures. The innovative approach is that the surfaces are patterned in a process called Direct Laser Interference Patterning (DLIP) using ultra-short pulses (USP). The surfaces will be evaluated for biofilm formation rates under different spaceflight relevant gravitational regimes (Mars, ISS and Earth control) and bacterial growth will occur under optimal biofilm-inducing conditions in the KUBIK incubator inside ESA's Columbus laboratory.

Preflight experiments, performed on ground (1g), showed that the BIOFILMS hardware is biocompatible and allows biofilm formation of all three bacterial species on the reference steel surfaces. The use of pure copper and brass surfaces inside the hardware significantly reduced bacterial growth and biofilm formation. In our preliminary experiments, the DLIP nanostructured copper surfaces were more effective than the smooth surfaces.

The obtained results from the BIOFILMS experiment will be of immense importance for understanding the influence of gravity on biofilm formation and on the effectivity of USP-DLIP antimicrobial copper surfaces. Furthermore, the evaluation of different antimicrobial materials in microgravity is relevant for present and future astronaut-/robotic-associated activities in space exploration. Here, an overview on the ongoing and upcoming activities of the ISS spaceflight experiment BIOFILMS is presented.