Part of the COSMIC KISS Mission
of Matthias Maurer

Image: ESA

Image: NASA

Advanced Surface Research in the International Space Station

——The effects of surface topography on microorganisms

UNIVERSITÄT DES SAARLANDES

Material Engineering Center Saarland (MECS)
Steinbeis-Forschungszentrum

DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

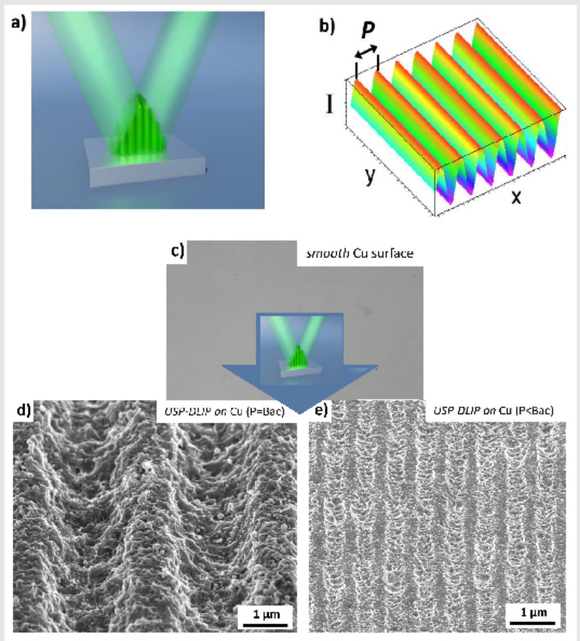
BioServe Space Technologies

Massachusetts Institute of Technology

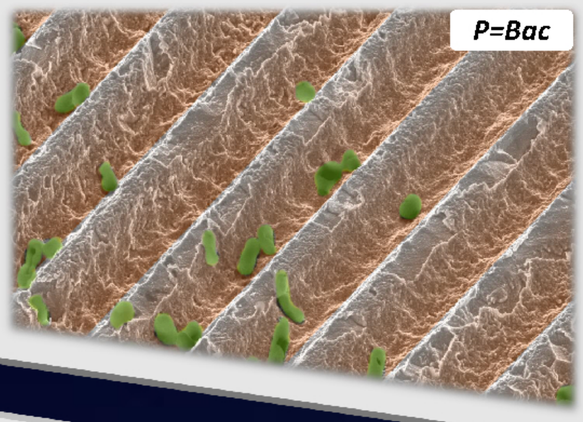
Universidad del Valle de Guatemala

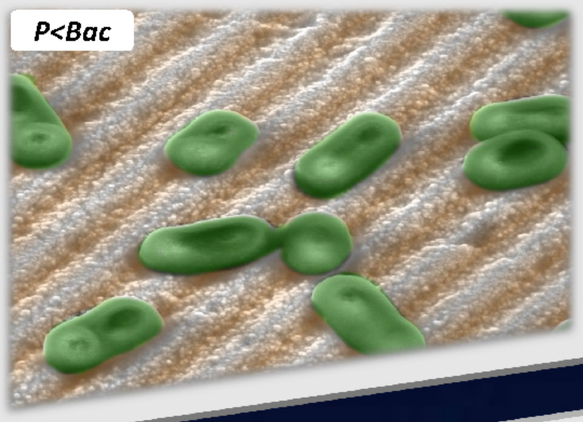
NASA

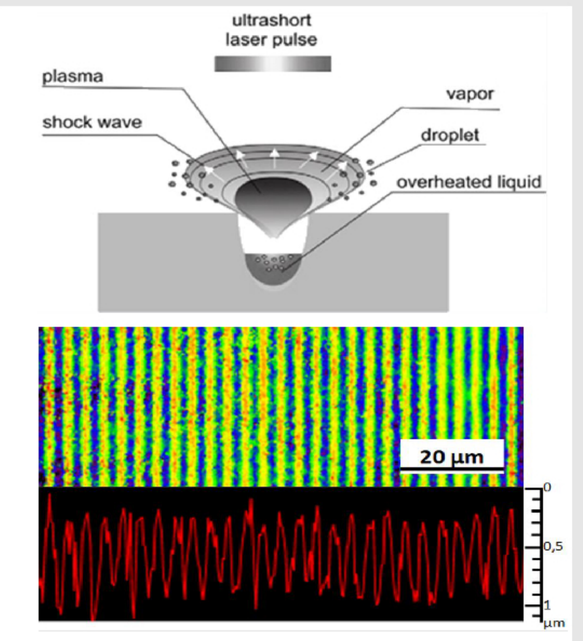
esa



In the current cooperative ISS experiments of the **Institute of Aerospace Medicine, German Aerospace Center (DLR e.V.)**, Cologne and the **Chair of Functional Materials, Saarland University** on the antimicrobial properties of Copper-based metallic surfaces, a novel laser-based methodology is applied for surface functionalization: **Ultrashort Pulsed Direct Laser Interference Patterning (USP-DLIP).** Via Femtosecond Pulsed USP-DLIP various materials like polymers as well as metals can be patterned in the length scale of several micro- down to sub-micrometer. Using this technique, different surface topographies can be applied on the metallic surfaces tested to alter Bacteria/surface interaction: **Pattern scales in the size range of single bacteria cells (P=Bac) enhance adhesion and bacterial activity, while smaller pattern (P<Bac) scales decreases both parameters.**







BIOFILMS

Testing antimicrobial surfaces under space flight conditions

Uni. Saarland: Daniel Müller, Aisha Ahmed, Sandra Baur, Kristina Brix, Ralf Kautenburger, Frank Mücklich
DLR: Katharina Siems, Ralf Moeller
SCK-CEN: Laurens Maertens, Rob van Houdt
RKI: Michael Laue, Gudrun Holland
KI: Alessandra Tortora & Team
ESA: Nicol Caplin, Jutta Krause, Rene Demets, Marco Vukich
BAER Institut/NASA: Rocco L. Mancinelli
BIOTESC: Christian Roesch

The aim of the BIOFILMS project is to **investigate the influence** of the topographical and chemical surface properties on bacterial interaction during biofilm formation on **actively antibacterial** and **inert metallic surfaces.**

Background

Current research results from the ISS show that **pathogens** and **biofilms on manned space stations** pose a much greater threat to the health of astronauts than previously assumed. In microgravity, germs show various adaptation strategies like **altered biofilm morphology** and adhesion strength along **increased pathogenicity**.

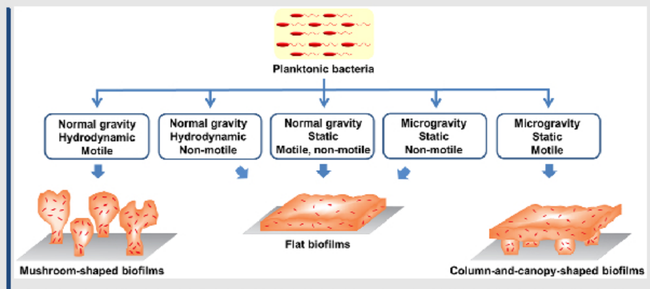


Fig. 1 Biofilm formation in different environments leading to different biofilm morphologies.

Advanced surface research

- The bacteria are offered **specifically modified surfaces** for planktonic colonization and biofilm formation, where the topography has been optimized particularly **enhanced** or **reduced adhesion possibilities** by USP-DLIP.
- Several Copper alloys as well as stainless steel are used to **monitor the biofilm formation** on both toxic and inert surfaces in relation to the modified surface properties.
- By modifying the gravitational parameter in the experiments on the ISS, the **micro-gravitational influence** on the behaviour of the bacteria will be studied, as well.

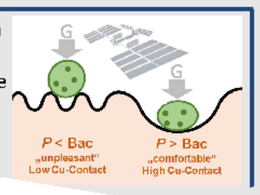


Fig. 2 Surface modification for altered bacterial adhesion also involving the influence of gravitation.

Fig. 3 ESA-Astronaut Thomas Pesquet installs first BIOFILMS Experiment inside the KUBIK Incubator on the ISS.

Touching Surfaces

Testing antimicrobial surfaces for space flight and earth applications

DLR: Katharina Siems, Franca Arndt, Christoph Steger, Freya Scheffler-Kayser, Ralf Moeller
Uni. Saarland: Daniel Wyn Müller, Aisha Ahmed, Frank Mücklich
UCL: Malica Schmidt
ESA: Sabine Ansel
BIOTESC: Chiara Burkhardt

Background

Long-term stays of humans in a space station lead to the development of their own "spaceflight"-microflora from the microorganisms carried along. This can have an impact on the health of astronauts - especially if their composition changes under the conditions of spaceflight. Furthermore, the development of biofilms can lead to serious material degradation. In **Touching Surfaces** USP-DLIP functionalized surfaces are investigated for their **antimicrobial effectiveness and hygiene maintaining properties** when applied as contacting surfaces **under space conditions.**

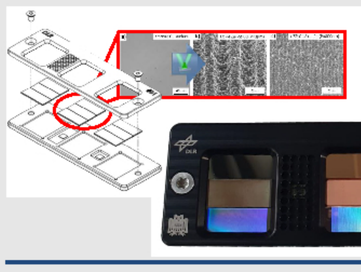


Fig. 1 Touching Array with different USP-DLIP functionalized sampling surfaces

- Touching Arrays are mounted at **different locations within the ISS** containing antimicrobial metallic surfaces with and without USP-DLIP functionalization.
- The various surfaces will be **touched regularly** and subsequently **studied on Earth by microbiological and materials science methods.**
- The experiment also involves exposure sites in terrestrial hospitals and allows students to participate with own experiments as part of the **DLR "Citizen Science"-program.**

This research is aiming to evaluate the ability of these antimicrobial surfaces to reduce or prevent microbial spread within the ISS. The antimicrobial efficiency will be related to the **special environmental conditions on the ISS** (i.e., radiation, microgravity, isolation, temperature, humidity).

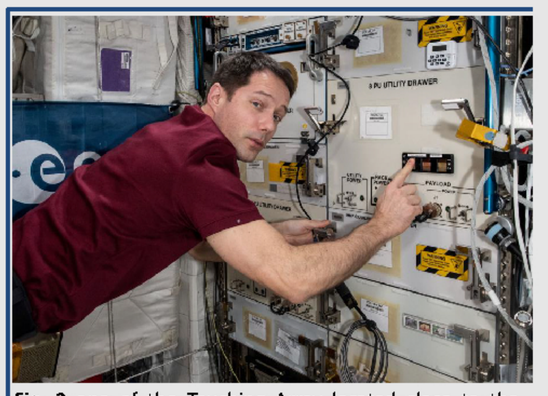


Fig. 2 one of the Touching Array located close to the Japanese Experimental Module (JEM, alias KiBō) within the ISS.

FuWe Functional Materials

Kupfer-Symposium 2021

Werkstofftagung vom 24.-25. November 2021 in Jena