

The BOSS Experiment of the EXPOSE-R2 Mission: Biofilms versus planktonic cells

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In the BOSS experiment (biofilm organisms surfing space), which was performed in the context of the successfully finalized EXPOSE-R2 mission, an international consortium of scientists investigated the ability of a variety of organisms to survive in space and on Mars as a function of their life style. The question in focus is whether there are different strategies for individually living microorganisms (planktonic state) compared to a microbial consortium of the same cells (biofilm state) to cope with the unique mixture of extreme stress factors including desiccation, gamma-, ionizing- and UV radiation in this environment. Biofilms, in which the cells are encased in a self-produced matrix of excreted extracellular polymeric substances, are one of the oldest clear signs of life on Earth. Since they can become fossilized they might also be detected as the first life forms on other planets and moons of the solar system and are therefore ideal candidates for astrobiological investigations. As an example for the organisms that attended the EXPOSE-R2 mission the results of the flight and mission ground reference analysis of *Deinococcus geothermalis* are presented. *Deinococcus geothermalis* is a non-spore-forming, gram-positive, orange-pigmented representative of the *Deinococcus* family which is unparalleled in its poly-extreme resistances to a variety of environmental stress factors on Earth. The results demonstrate that *Deinococcus geothermalis* remains viable in the desiccated state over almost 2 years, whereas culturability was preserved in biofilm cells at a significantly higher level than in planktonic cells. Furthermore, cells of both sample types were able to survive simulated space and Martian conditions and showed high resistance towards extra-terrestrial UV radiation. Additionally results of cultivation-independent investigations of pigment stability, membrane integrity, enzyme activity, ATP content and DNA integrity will be discussed. To conclude, biofilms exhibit an enhanced rate of survival compared to their planktonic counterparts when exposed to space and Martian conditions. This seems to indicate an advantage of living as a biofilm when facing the poly-extreme conditions of space or Mars. The findings will contribute to the understanding of the opportunities and limitations of life under the extreme environmental conditions of space or other planets as function of the state of life and aims to contribute to the understanding of the adaptation mechanisms that allow microorganisms to survive in extreme environments, possibly including space and the surface of Mars.