Surface Characteristics of Spacecraft Components Affect the Aggregation of Microorganisms and May Lead to Different Survival Rates of Bacteria on Mars Landers

Andrew C. Schuerger[1], Jeffrey T. Richards[2], Paul E. Hintze[3], and Roger G. Kern[4]

[1] University of Florida, Bldg. M6-1025, Space Life Sciences Lab, Kennedy Space Center, FL 32899; acschuerger@ifas.ufl.edu
[2] Dynamac Corporation, Mail Code DYN-3, Space Life Sciences Lab, Kennedy Space Center, FL 32899
[3] Corrosion Technology Testbed, Mail Code ASRC-15, Kennedy Space Center, FL 32899
[4] Jet Propulsion Lab, Mars Exploration Directorate, Pasadena, CA 91109

Florida Agricultural Experiment Station, Journal Series Paper R-10797.

Corresponding author: Andrew C. Schuerger; University of Florida, Bldg. M6-1025, Space Life Sciences Lab, Kennedy Space Center, FL 32899; 321-861-3478 (tel); 321-861-2925 (fax); acschuerger@ifas.ufl.edu

Running title: Bacterial survival on spacecraft materials on Mars.

Keywords: Mars, astrobiology, planetary protection, spacecraft materials

Abstract

Layers of dormant endospores of *Bacillus subtilis* HA101 were applied to eight different spacecraft materials and exposed to martian conditions of low pressure (8.5 mb), low temperature (–10 ^{o}C), high CO_2 gas composition, and irradiated with a Mars-normal UV-VIS-NIR spectrum. Bacterial layers were exposed to either 1 min or 1 hr of Mars-normal UV irradiation, which simulated clear-sky conditions on equatorial Mars (0.1 *tau*). When exposed to 1 min of Mars UV irradiation, the numbers of viable endospores of *B. subtilis* were reduced 3-4 orders of magnitude for two brands of aluminum (Al), stainless steel, chemfilm-treated Al, clear-anodized Al, and black-anodized Al coupons. In contrast, bacterial survival was reduced only 1-2 orders of magnitude for endospores on the non-metal materials astroquartz and graphite composite when bacterial endospores were exposed to 1 min of Mars UV irradiation. When bacterial monolayers were exposed to 1 hr of Mars UV irradiation, no viable bacteria were recovered from the six metal coupons listed above. In contrast, bacterial survival was reduced only 2-3 orders of magnitude for spore layers on astroquartz and graphite composite exposed to 1 hr of Mars UV irradiation. Scanning electron microscopy images of the bacterial monolayers on all eight spacecraft materials revealed that endospores of *B. subtilis* formed large aggregates of multilayered spores on astroquartz and graphite composite, but not on the other six spacecraft materials. It is likely that the formation of multilayered aggregates of endospores on astroquartz and graphite composite is responsible for the enhanced survival of bacterial cells on these materials.