

Sealing and Sealing Monitoring System for Mars Sample Return

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In the frame of the Mars Sample Return mission, a novel concept for a sealing and sealing monitoring system has been developed. The sealing system is designed to safely bring Martian soil and atmosphere samples to Earth for analysis on potential life. The described sealing and sealing monitoring system is compliant with class V planetary protection requirements.

The governing planetary protection requirements have been translated into a set of quantifiable engineering requirements. These requirements have been assessed with respect to the characteristics of existing sealing technologies. This study showed that the most critical issue to comply with the planetary protection requirements, is breaking the link with the Mars environment. A market and technology research showed no convincing sealing concept within the imposed constraints.

For this reason, the study has focused on a new method for breaking the link with the Mars environment. The sealing system is based on a 'Sample Bag' in which the potentially contaminated Martian samples are contained. The Sample Bag is made of a thin metal foil and the bio-tight seal is applied using brazing technology. Breaking the link with Mars is established by cutting through the brazing seam. The obtained containment system has a guaranteed sterile outer surface. The rationale for the brazing technology is the melting temperature of the brazing material, which is above 500°C. At these temperatures, all carbon-carbon links are destroyed. Assuming that the bio-hazardous materials are built-up from C-C based molecules, all the potential contaminants, that could have been trapped in the brazing seam and would be exposed after cutting, are sterilised.

A test campaign has been executed to show the feasibility of the brazing process on thin metal foils. The test campaign has given insight in the different process parameters and their criticality. Special, non-destructive inspection techniques, which have been developed for the microelectronics industry, are used to inspect the quality of the brazing seam.

The sample bag design has been integrated in a system concept for the sealing system, incorporating the required level of containment barriers. The sealing system is equipped with a sealing monitoring system, based on leak detection by pressure moni-

toring. The applied pressure differentials introduce a number of additional bio-barriers due to the fact that, in case of seal leakage, particles will not be able to migrate out of their containment. The information, provided by the sealing monitoring system, will trigger the decision whether the Mars samples can be brought into the Earth-Moon system.