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SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 3 (3C)

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MARS EXPLORATION: THERMO-MECHANICAL AND CHEMICAL BEHAVIOUR OF KEVLAR AND NYLON FOR PARACHUTE APPLICATIONS

Abstract

The ESA ExoMars program is proposed to investigate Martian environment and to test new flight and scientific technologies. These include Entry, descent and landing (EDL) of a payload on the surface of Mars. From this point of view the development of the ExoMars Parachute for the descending phase on Mars planet is very important. The parachute system consists in three main components: the parachute, the parachute deployment device, and the cover. The design of each component has to take into account the degradation of the mechanical properties of the material and fabrics due to the interaction with the Mars environment and with the different stresses induced by the transfer from the earth. So, the design of the joint as a fundamental component follows the results of the test characterization. The strength of polymers (Nylon 66, in particular) can vary significantly with the operating temperature. It is important to evaluate the strength of the material and its variability with the operating temperature and to modify test loads to account for temperature-strength variability if it is tested at a different temperature (ambient, cold and hot tensile test campaigns). The aim of this paper is the investigation of the effects of different environment-conditions on Kevlar and Nylon 66 materials and the design of the main components of the parachute. The samples and structure joint will be subjected to different cycles of conditioning in order to investigate the effects of the interactions with Mars environment. The different environments are simulated by a dedicated facilities specifically designed by SASLab Laboratories for Mars environment simulation. The conditioning cycles consists in a UV exposition, Vacuum Stripping and Thermal Cycling conditioning. The effects of these interactions on the conditioned materials and structures will be investigated by a mechanical tests campaign performed in three different thermal conditions representative of the critical

temperature profiles of Mars exploration mission: an intermediate phase of tensile tests after UV and VS conditioning (IT1 IT2), a phase of tensile tests on non-conditioned materials (Beginning of Life), and a final phase of tensile tests on conditioned samples (End of Life). Solid state NMR Spectroscopy and NMR Relaxometry will be carried out before and after each step of conditioning and test to investigate structural variations in Kevlar and Nylon possibly occurring after tests.