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Title

Characterization of self-healing polymers under simulated space environment

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Abstract

Due to recent advances in space technologies, extended human missions on the Moon and Mars are likely to take place soon. The consequently related issue of prolonged exposure of crewmembers and devices to the threats of space environment will lead to stricter requirements on the spacecraft reliability, functionality, safety, and autonomy. As traditional architectures are typically unable to satisfactorily meet all these requirements, new solutions must be considered. Among them, self-healing inflatable structures, characterised by the presence of a layer of self-healing material, are becoming increasingly interesting because they would ensure partially or totally autonomous and rapid functionality restoration after a damaging event such as an impact with micrometeoroids or orbital debris (MMOD) [1,2]. Combined with the high packing efficiency and light weight of inflatables [3], this would result in higher safety and reliability and lower mission costs [4,5].

Nevertheless, little information regarding the effects of the combined action of space environmental factors such as high vacuum, ATOX, radiation and MMOD on self-healing materials is currently available [6]. A deeper knowledge of the synergistic effects of space environment on these materials is hence necessary to assess their applicability to space missions.

In the here proposed work a set of self-healing polymers is selected and subjected to the action of some of the main environmental components of space, simulated through the laboratory facilities at the ESTEC location of the European Space Agency. Irradiation, outgassing, ATOX, UV-thermal vacuum tests are performed. The polymers are characterised before and after conditioning to determine the effects of space environment on their physical, mechanical, and self-healing properties. Thermal, thermo-optical, spectroscopic, and rheological characterisations are made to assess physical and mechanical properties variation, as well as surface change inspection through optical microscopy.

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