Paper ID: 69344
oral

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (9)

Author: Ms. Laura Pernigoni
Politecnico di Milano, Italy, laura.pernigoni@polimi.it

Dr. Ugo Lafont
ESA, The Netherlands, Ugo.Lafont@esa.int
Dr. Antonio Grande
Politecnico di Milano, Italy, antoniomattia.grande@polimi.it

SELF-HEALING POLYMERS FOR SPACE: A STUDY ON AUTONOMOUS REPAIR PERFORMANCE AND RESPONSE TO SPACE RADIATION

Abstract

One of the main challenges of space exploration is to design novel light, initially packed structures that both make the best use of the reduced transport capacity of the available launchers and ensure safety and reliability levels comparable to those of classical solutions. For this reason, space inflatable structures have recently gained interest: initially folded in stowed configuration to fit in the launcher's space dedicated to the payload, they can be then inflated and deployed to reach the required volume. In addition, these structures are much lighter than traditional ones and would significantly reduce the related mission costs.

However, these solutions are currently unable to withstand damages after, for example, impacts with micrometeoroids and orbital debris (MMOD), and they would depressurise and collapse if punctured, with catastrophic consequences for devices and astronauts in case of crewed missions. In this context, the possibility of integrating self-healing materials into inflatable and deployable space structures has drawn the attention of the scientific community, as it would lead to autonomous damage restoration and subsequently increased spacecraft safety, operational life, and autonomy. Nevertheless, the effects of space environment on these materials are still to be determined and could lead to a significant decrease of their overall performance.

The here presented study analyses both healing performance and variation of functional properties due to simulated space radiation of a set of candidate self-healing polymers for space applications, either studied as matrices into nanocomposites or inserted into multilayer composites.

The self-healing response is assessed through in-situ flow rate measurements after puncture damage. Maximum and minimum flow rate, the time between them and the air volume lost within the 3 minutes following puncture are collected as healing performance parameters. The same tests are then repeated on gamma-ray irradiated samples to study the variation in self-repairing performance after exposure to simulated space radiation. Results show that the healing performance is higher in systems with lower viscous response, and that this performance decreases in the irradiated samples. A further analysis of the effects of space environment on the presented materials is hence required.

The HZETRN2015 NASA software is also used to simulate galactic cosmic rays and solar proton events. After comparing the materials to identify the most promising candidates, simulations on lunar and Martian surfaces are performed on them and different options are considered to increase their shielding performance.