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EXPERIMENTAL CHARACTERIZATION OF MULTI-LAYER 3D-PRINTED SHIELDS FOR MICROSATELLITES

Abstract

In recent years, innovative processes such as addictive manufacturing are finding application in the satellites industry, allowing solutions whose implementation could have been difficult or expensive using traditional manufacturing techniques. In the framework of the EU H2020 ReDSHIFT project, new 3D-printed shields were developed for microsatellites protection: (1) a multi-shock panel comprising four equally-spaced 3D-printed bumper layers, and (2) a two-walls panel with outer bumper layers sandwiching a corrugated core. These shields were evaluated with respect to their resistance to hypervelocity impacts of mm-size debris and to radiation fluxes expectable in the LEO environment. In addition, preliminary tests were also done on simple plates realized with standard manufacturing techniques and with 3D-printing, in order to highlight possible effects just related to the additive process.

This paper presents the results of hypervelocity impact and radiation tests carried out at the University of Padova on the proposed panels. On one hand, the debris-shielding properties were evaluated with respect to the damage on targets and witness plates placed behind them. In addition, debris clouds resulting from panels perforation were observed qualitatively through high-speed imaging, and the momentum transferred to witness plates was evaluated as well using a ballistic pendulum. On the other hand,

the radiation-shielding capabilities were assessed using a high-energy proton beam - protons are one of the most abundant ionizing particles in low orbits - and a combination of radiation sensors and relevant electronic chips. In particular, RadFETs were used to measure the amount of total ionizing dose with and without the interposition of the shields. In addition, Flash memories exposed to the proton beam, again with and without the shields, were used to directly evaluate radiation effects on chips relevant for space applications.