SPACE DEBRIS SYMPOSIUM (A6)
Hypervelocity Impacts and Protection (3)

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HONEYCOMB VS FOAM: EVALUATING POTENTIAL UPGRADES TO ISS MODULE SHIELDING

Abstract

The presence of honeycomb cells in a dual-wall structure is advantageous for mechanical performance and low weight in spacecraft primary structures but detrimental for shielding against impact of micrometeoroid and orbital debris particles (MMOD). The presence of honeycomb cell walls acts to restrict the expansion of projectile and bumper fragments, resulting in the impact of a more concentrated (and thus lethal) fragment cloud upon the shield rear wall. The Multipurpose Laboratory Module (MLM) is a Russian research module scheduled for launch and ISS assembly in 2011 (currently under review). Baseline shielding of the MLM is expected to be predominantly similar to that of the existing Functional Energy Block (FGB), utilizing a baseline triple wall configuration with honeycomb sandwich panels for the dual bumpers and a thick monolithic aluminum pressure wall. The MLM module is to be docked to the nadir port of the Zveda service module and, as such, is subject to higher debris flux than the FGB module (which is aligned along the ISS flight vector). Without upgrades to inherited shielding, the MLM penetration risk is expected to be significantly higher than that of the FGB module. Open-cell foam represents a promising alternative to honeycomb as a sandwich panel core material in spacecraft primary structures as it provides comparable mechanical performance with a minimal increase in weight while avoiding structural features (i.e. channeling cells) detrimental to MMOD shielding performance. In this study, the effect of replacing honeycomb sandwich panel structures with metallic open-cell foam structures on MMOD shielding performance is assessed for an MLM-representative configuration. A number of hypervelocity impact tests have been performed on both the baseline honeycomb configuration and upgraded foam configuration, and differences in target damage, failure limits, and derived ballistic limit equations are discussed.