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

Author: Mr. Martin Rudolph
Fraunhofer EMI, Germany, martin.rudolph@emi.fraunhofer.de

Dr. Frank Schäfer
Fraunhofer EMI, Germany, frank.schaefer@emi.fraunhofer.de
Dr. Roberto Destefanis
Thales Alenia Space Italia, Italy, roberto.destefanis@thalesaleniaspace.com
Mr. Moreno Faraud
Thales Alenia Space Italia, Italy, moreno.faraud@thalesaleniaspace.com
Mr. Michel Lambert
European Space Agency (ESA), The Netherlands, Michel.Lambert@esa.int

FRAGMENTATION OF HYPERVELOCITY ALUMINUM PROJECTILES ON FABRICS

Abstract

Inflatable modules for space applications offer great potential, in particular for long-lasting manned missions. Flexible shielding solutions are required in order to protect the structure from the Micro-Meteoroid and Space Debris (MM/SD) environment. Currently, fabrics like Nextel and Kevlar are being used as energy-dissipating layers in high-performance rigid shields such as the one on the Columbus module of the International Space Station (ISS) or the pressurized section of the Automated Transfer Vehicle (ATV). However, in general, the behavior of fabrics under hypervelocity impacts is not well understood. In particular, fragmentation of hypervelocity projectiles is a critical process since it significantly contributes to the overall ballistic performance of a shield. This paper presents parts of a study funded by the European Space Agency (ESA) with Thales Alenia Space – Italia being the prime contractor. It experimentally evaluates the ability of different flexible materials to induce fragmentation of a hypervelocity projectile. Samples were chosen to represent a wide range of industrially available types of fabrics like ceramic, aramid, metal and carbon fabrics. Impact conditions and areal density for each target were kept constant by adding one or more sheets of material. Thermal system engineering constraints usually require Betacloth and Multi-Layer Insulation (MLI) to cover the MM/SD shield and since its ballistic influence cannot be neglected, it was attached on top of each sample. All tests were performed with the Space Light Gas Gun (SLGG) of the Fraunhofer Ernst-Mach-Institut (EMI) with spherical aluminum projectiles impacting at around 6.3 km/s. The primary analysis tool was a witness plate placed behind the target. Results show performances ranging from a sample composed of a ceramic fabric being the worst performer to an aramid fabric showing the best performance. A comparison with an equal-density rigid aluminum plate was performed.