MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Environmental Effects and Spacecraft Protection (6)

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HYPERVELOCITY DEBRIS IMPACT DAMAGE OF SPACE COMPOSITE STRUCTURES

Abstract

The increasing amount of debris in Earth orbit poses a danger to users of the orbital environment. During the design phase of a spacecraft, an important requirement may be specified for the survivability of the spacecraft against Meteoroid / Orbital Debris (M/OD) impacts throughout the mission; moreover, the spacecraft structure is designed to guarantee its integrity and reliability during the launch and, if it is reusable, during descent, re-entry and landing. In addition, the structure has to provide required rigidity for exact positioning of experiments and antennas, and it has to protect the payload against the space environment. In this frame, in order to decrease the probability of spacecraft failure caused by impacts, for M/OD with dimensions less than 1cm, shields are needed for every spacecraft. It is therefore necessary to determine the impact-related failure mechanisms and associated ballistic limit equations (BLEs) for typical spacecraft components and subsystems. In order to obtain the ballistic limit equations, numerical simulations and laboratory experiments are required. A high energy ballistic characterization of layered structures has been carried out by means of a new advanced electromagnetic accelerator, called railgun, that has been assembled and tuned. A railgun is an electrically powered linear electromagnetic projectile launcher. Such device consists of a couple of parallel conducting rails, that allow sliding metallic armature to be accelerated along, by the electromagnetic effect (Lorentz force) of a current flowing down one rail, into the armature and then back along the other rail, thanks to a high power pulse given by a capacitors bank. A tunable power supplier is used to set the capacitors charging voltage at the desired level: in this way the Railgun energy can be tuned as a function of the desired bullet velocity. In such a way this facility is able to analyze both low and high velocity impacts. A numerical simulation is also carried out, using the Ansys Autodyn code, in order to analyze the exposed structures and verify the correct behavior of the facility. The experimental and numerical simulations results show that the railgun device can be used to perform impact testing of materials in the space debris energy range.