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

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DISTRIBUTION OF DEBRIS CLOUD CAUSED BY HYPERVELOCITY IMPACT ON AL-FOAM BUMPER

Abstract

It's important to improve and optimize the shields used to protect the manned elements against impacts of micro-meteoroids and orbital debris. Tests have identified that metallic foams have a good shielding performance against M/OD hypervelocity impact, so metallic foams may play a key role in the structural design of manned spacecraft and satellite in the future. To investigate the distribution of debris cloud caused by hypervelocity impact on Al-foam bumper comparing with solid aluminum, numerical simulations were carried out in the velocity range of 3-9km/s at normal incidence. As the pore size of foam material is too big to be ignored comparing with projectile diameter or bumper width, a SPH program was developed in which metallic foams are regarded as discontinuous medium and pores are created in the metal to model the real geometry of foam material. Thus the material model parameters needed in simulation for metallic foams are just those of original metal material, which have been developed extensively and successfully. The validation of the model had been tested by both experiments and numerical simulations. The case under research used Al 2024 for all materials including the foam matrix. The projectile is a 3mm diameter sphere. The Al-foam has a density of 0.65g/cm3 and 6mm in thickness. Its mean pore size is 1mm in diameter. The contrastive solid aluminum bumper has a thickness of 1.4 mm to keep the same areal density as that of Al-foam. The distributions of mass and kinetic energy of debris cloud were obtained at different spread angles which are defined from the impact axis. The simulation results indicate that mass distribution of debris cloud caused by impact on Al-foam bumper shows two peaks at different velocities within 0-45 degrees. While the kinetic energy distribution of debris cloud shows only one peak within 0-15 degrees. The mass and kinetic energy of debris cloud caused by impact on Al-foam bumper are more dispersive at higher velocities than those of solid aluminum bumper. This feature will help to decrease the risk of spacecrafts against space debris with high speed.