Numerical Simulation of Major Debris-Cloud Features Produced by Projectile Hypervelocity Impact on Bumper

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All spacecrafts in low orbit are subjected to hypervelocity impacting by meteoroids and space debris. These impacts can damage spacecraft flight-critical systems, leading to catastrophic failure of the spacecraft. In order to protect the safety of an orbiting spacecraft, the shield for meteoroids and space debris becomes an indispensable factor in the design of a spacecraft, especially those with long orbital life and large size structures. Because the major debris-cloud represents the most severe threat to rear wall integrity, researches on the major debris-cloud features are very important. In this paper, the numerical simulations for major debris-cloud features produced by a sphere projectile normal impacting on a single-sheet bumper at hypervelocity have been carried out using the SPH technique of AUTODYN. The major debris-cloud features include the effects of debris-cloud morphology, normalized axial velocity and radial velocity. These features vary with bumper-thickness-to-projectile-diameter ratios (t/D) and impact velocities. The impact velocities are from 1 to 14km/s. The bumper and projectile materials are aluminum. The ratio t/d is from 0.0105 to 0.525. Effects of impact velocity and t/d on the major debris-cloud features have been investigated. It is shown that the major debris-cloud features have remarkable differences with various t/d and impact velocities. As the t/D ratio is increased and impact velocity is constant, the major debris-cloud morphology varies. The diameter of center element and the radial debris-cloud velocities increases. At the same time, radial expansion and the shell of spall fragments at the rear element, size of fragments in the center and rear elements and the axial debris-cloud velocities decreases. As t/D ratio is held constant, debris-cloud hardly occurs at the low velocity. As the impact velocity increases, fragmentation of sphere and radial expansion of internal elements increase. At the same time, the axial debris-cloud velocities increase and the radial debris-cloud velocities increase. The simulation results show that the bumper thickness has an optimizing value.