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ACCUMULATIVE DAMAGE OF REAR WALL OF SHIELD BY REPEAT IMPACTS OF HIGH-SPEED PROJECTILES AT DIFFERENT AMBIENT TEMPERATURE

Abstract

Space environment is a major cause for the induced fault of spacecraft in orbit. Space environment is mainly including vacuum environment, temperature environment, electron irradiation environment, etc., among them, the temperature environment is a main factor influencing the performance of spacecraft surface structure. The space debris shield is usually located in the outermost layer of the spacecraft, and temperature change of the protective material is very intense, which material performance are influenced by ambient temperature. At the same time, with the increase of the number of space debris, the probability of multiple impacts on the same part of the spacecraft increases. Therefore, it is necessary to study effect of different ambient temperature on accumulative damage of spacecraft protection structure under high-speed projectile repeat impacts. For this study, a two-stage light gas gun is used to launch 2017-T4 Al-sphere projectiles repeatedly impacting on Al-plate shields and woven stuffed shields in test chamber at different ambient temperature respectively. Before the second impact, the aluminum plate and stuffed materials impacted in bumper will be replaced with new ones without rear wall. Accumulative damage of rear wall of Al-plate shields and woven stuffed shields by repeat impacts of high-speed projectiles at different ambient temperature are studied. The diameters of projectiles used to simulate space debris are 3.18mm and 3.97mm respectively. Impact velocities of Al-spheres projectiles are varied between 2.48km/s and 4.37km/s. The impact angle is 0 for all the tests. Ambient temperatures are approximate 193K, 293K and 463K respectively. The pressure in test chamber is approximate 200Pa. The study focus on accumulative damage of rear wall of shield by repeat impacts at different ambient temperature and the influence of ambient temperature on damage and protection characteristic of shield. The results indicate that the space between two center points of impacts twice is a main factor influencing accumulative damage of rear wall of shield, which the smaller the space between two center points, the more significant the accumulative damage of rear wall. At the same time, alternating ambient temperature weakens the protection performance of shields, and high ambient temperature reduces woven material properties, leading protection performance of woven stuffed shield degradation, as well, low ambient temperature results opposite conclusions. In addition, accumulative damage of rear wall of shield is coupling of ambient temperatures and multiple impacts.