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DAMAGE OF QUARTZ GLASS UNDER HYPERVELOCITY IMPACT

Abstract

Quartz glass is widely applied as components of spacecraft, such as the portholes, optical components and solar battery panels. Due to its low tensile strength, Quartz glass has different impact characteristics from that of ordinary metals, and will be cracked and shattered when impacted by a hypervelocity projectile. It is useful to study the impact characteristics of porthole quartz glass for spacecraft's MMOD risk assessments.

Hypervelocity impact (HVI) tests and numerical simulations for aluminum projectiles impacting porthole quartz glasses were performed. Nine HVI shots were carried out with two-stage light gas gun with 1 mm-5 mm diameters projectiles at impact velocities of 3-7 km/s and 0 impact angle. Both of the two kinds of quartz glass targets test in this paper had the same thickness of 12 mm. However, type I had diameter of 100 mm and was set up with fixed boundary condition, type II had diameter of 250 mm and was set up with free boundary condition. The damage characteristics of porthole quartz glasses under hypervelocity impact have been obtained. It was found that some damage occurred on symmetrical position of impact point besides shatters on impact point and cracks on edge, and the influences of impact point, target size and boundary condition on damage were significant.

Numerical simulations were performed with SPH method to investigate the process of aluminum projectiles impacting porthole quartz glasses. The phenomenon that the damage emerged on symmetrical position of impact point had been reconstructed. It is regarded that the shockwaves reflecting at glass edge focused on the symmetrical position of impact point many times and tensed local material many times too, until the tensile stress reach the decreased transient strength of material. Then the influences of impact point, target size and boundary condition on damage of circular target were studied, and some suggestion of decreasing edge effect damage were made out and the effects were verified with numerical simulation.