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

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NEW EVIDENCES FOR HIGH PERFORMANCE OF GONG-HOU SHIELD IN WITHSTANDING HYPERVELOCITY IMPACT

Abstract

Experimental researches were carried out on two new types of Gong-Hou shield on two-stage light gas gun, which were Al/Mg shield and Ti/Al/Mg/nylon shield, to verify that density-grade material performed better than aluminum alloy in withstanding hypervelocity impact (HVI) and Gong-Hou shield had larger protection capacity than Whipple shield in defeating micro-meteoroid and orbital debris (MM/OD). The Al/Mg density-grade bumper comprised 0.8 mm AL 2024-T4 and 1.1 mm MgAZ31B, and the Ti/Al/Mg/nylon density-grade bumper consisted of 0.4 mm Ti6Al4V, 0.3 mm AL 2024-T4, 0.3 mm MgAZ31B, and 0.9 mm nylon (all in thickness). The spacing was 100 mm and the rear wall was 3.0 mm AL 2024-T4 for both shields. Three impact velocities (3.5 km/s, 4.5 km/s, and 6.5 km/s) were chosen for Al/Mg shield. For Ti/Al/Mg/nylon shield, experiments were conducted at 4.5 km/s and 6.5 km/s. Petal-like perforations presented in both Al/Mg bumper and Ti/Al/Mg/nylon bumper, which took on similar morphology to Ti/Al/nylon shield experiments carried out before. The specific perforation diameters for Al/Mg shield and Ti/Al/Mg/nylon shield were approximately 1.3 to 2.1 times of those for Whipple shield. The perforation holes of Al/Mg shield were larger than those of Ti/Al/Mg/nylon shield at 4.5 km/s, but they seemed equal at 6.5 km/s. The morphologies of debris clouds in Al/Mg shield and Ti/Al/Mg/nylon shield showed that the particle size was smaller than that of Whipple shield. Particles distributed evenly in both types of Gong-Hou shield, and particle concentration area took half volume of debris cloud. In contrast, particles of Whipple shield concentrated in front of debris cloud which took less than 1/4 volume. This was proved by damage on rear wall. There were only 20-25 caters with diameter larger than 2 mm in Gong-Hou shield at 4.5 km/s, while more than 60 presented in Whipple shield. These HVI Characteristics made Gong-Hou shield possess higher performance compared with Whipple shield. The critical diameters of aluminum spherical projectiles for Al/Mg shield were 5.0 mm, 5.5 mm, and 6.0 mm at impact velocities of 3.5 km/s, 4.5 km/s, and 6.5 km/s, respectively. Those for Ti/Al/Mg/nylon shield were 4.8 mm at 4.5 km/s and 5.9 mm at 6.5 km/s. However, the maximum diameters of projectiles that Whipple shield could defeat were only 2.7 mm, 3.3 mm and 4.5 mm at 3.5 km/s, 4.5 km/s and 6.5 km/s, respectively. The maximum performance increase was 85.2%, and the minimum was 31.1%