Effects of bumper size on high velocity impact damage to Whipple shield

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With the increasing number of space mission, the impact risk on spacecraft at hypervelocity by space debris is increasing. A collision with space debris can cause damage to a spacecraft in low Earth orbit. For designing spacecraft protection constructions and developing advanced debris shieldsčňhypervelocity impact simulation experiments on the ground and the computer simulation of hypervelocity impact is the important means. The choice of shields modle sizes is a important step both in the experiments and computer simulation .Whipple shields are the basic structure configuration for protecting spacecraft from meteoroid and orbital debris, and are still extensively adopted.

This paper explores the bumper size effects on the damage produced by high velocity impacts on Wipple shields. Tests were performed using the non-powder two-stage light gas gun facilities at Hypervelocity Impact Research Center at Harbin Institute of Technology. The configuration of Wipple shields consisted of various sizes 1 mm thickness bumpers and constant size 3 mm thickness rear wall with 10 cm space btween the bumper and the rear wall. The bumpers used for the tests were made up of 8, 12, 16 and 20 cm square plate made from 2A12 Aluminum. All tests were performed with 4 mm in diameter aluminum projectile at velocity ranging from 1.45 to 1.71 km/s.

The limit velocity of projectile impacting on the Whipple shields in over 0.8 probability of penetration of rear wall, in probability of no-penetration of rear wall, and on critical penetration condition of rear wall was shown to be independent of bumper size. It was found that the penetration hold diameters ,and side slope degrees both in front and in back of bumper were independent of bumper size too; however, the deflection and concavo/convex direction on the bumper surface was dependent on bumper size obviously.