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BLC Derivation of a Stuffed Whipple Shield Based on Numerical Simulations

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ABSTRACT

Research of a shield to protect electronic equipment and crew of a space station from hypervelocity impact from space debris and meteoroids has been actively conducted. Recently, not only a Whipple shield consisting of two aluminum plate but also a shield containing advanced materials has been developed as an enhanced shielding. In general, impact tests using two-stage light-gas gun are mainly performed to evaluate the protective ability of a shield. The experimental results are used to derive ballistic limit curve (BLC) which represents the diameter and the velocity of a projectile where the failure of the shield has been occurred. However, it is possible to obtain only the result of the velocity region below 7km/s because the size and impact velocity of the projectile are limited in experiments [1]. Therefore, numerical simulations are required in order to obtain BLC in the whole velocity region of 1~15km/s.

In this study, we derive the simulation based ballistic limit curve of a stuffed Whipple shield that is used in the International Space Station (ISS) European Columbus module. The stuffed Whipple shield is composed of an aluminium bumper, a rearwall and intermediate bumpers consisting of advanced materials such as Nextel and Kevlar-epoxy. Numerical simulations are implemented by the commercial hydro-code package, AUTODYN-2D. In simulating the hypervelocity impact, the smoothed particle hydrodynamics (SPH) is used to represent debris cloud generated when the projectile collides with the bumper.

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REFERENCES

[1] E. L. Christiansen, *Meteoroid/Debris Shielding*, NASA Johnson Space Center, Houston, Texas, 2003.