Paper ID: 78199
student

21st IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Impact-Induced Mission Effects and Risk Assessments (3)

Author: Dr. Shengyu Zou
China Aerodynamics Research and Development Center(CARDC), China, zoushengyu999@163.com

Mr. Zhaoxia ma
China Aerodynamics Research and Development Center(CARDC), China, hai@cardc.cn
Dr. Wenpu Dong
China Aerodynamics Research and Development Center(CARDC), China, wenpu_dong@163.com
Dr. Ken Wen
China Aerodynamics Research and Development Center(CARDC), China, zoushengyu999@163.com

PROJECTILE SHAPE EFFECT ON FRAGMENT SIZE DISTRIBUTION IN A DEBRIS CLOUD PRODUCED BY A HYPERVELOCITY IMPACT ONTO THIN ALUMINUM PLATE

Abstract

Characterization of fragment size distribution in a debris cloud of thin-plate impact is essential for understanding fragmentation mechanism as well as for an evaluation of penetration potentiality of a debris cloud to subsequent structures. The purpose of this paper is to study the effect of projectile shape on fragment size distribution for aluminum thin-plate impact at hypervelocity. A set of hypervelocity impact tests were conducted by using a two-stage light-gas gun in CARDC. Aluminum projectiles of sphere (L/D=1), disc(L/D<1) and short-cylinder(L/D>1) were launched to velocities over 3km/s, to normal strike aluminum thin-plate targets. The fragments in the debris cloud were decelerated and caught by wax panels placed downrange. The fragments were recovered from the wax panels after the experiments and measured to determine their sizes and numbers. Based on the experimental results, the characteristics of largest fragments and fragment size-distribution corresponding to different projectile shapes were characterized and compared together. It is shown that the disc projectile is easiest to be fragmented, and the short-cylinder projectile is easier to be fragmented than the sphere. In addition, numerical simulations were performed to study the spall mechanism of each shaped projectile due to thin-plate impact, and to extend the study of fragment size-distribution characteristic of more other projectile shape. According to the analysis of experiment and simulation, a normalized fragment size-distribution model which incorporates the scaling laws of target thickness, projectile shape effect and impact velocity was proposed. After calibrating with experiment data, the model suggests the normalized fragment size-distribution is proportional to the projectile shape factor to the power of 1.75, and the model curve is shown in good agreement with the normalized fragment cumulative-number distribution obtained from experimental result, indicating the validity of the model was confirmed.

Key words: Hypervelocity impact, Fragment size-distribution, Thin-plate impact, Space debris