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

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A MODEL TO DESCRIBE THE SIZE DISTRIBUTION OF SATELLITE BREAKUP DEBRIS

Abstract

It is important for satellite breakup event analysis to describe the debris size distribution accurately since the debris characteristic length is the independent variable in breakup model and is directly linked to space observed data. In a commonly used breakup model, the debris size distribution is only related to the mass of both two objects in collision, without taking into account the influences of satellite size, structure density and impact conditions. To get a better understanding of the debris characteristics of satellite breakup, some hypervelocity impact tests and numerical simulation studies on simulant satellites are reported in this papergetting a new model to describe the debris size distribution. Satellite breakup tests under hypervelocity impact were performed at ballistic range of CARDC. The aluminum projectiles of blunt nosed cone were launched to normally impact the simulant satellites at velocities ranging from 3.0km/s to 4.0km/s. The simulant satellite was made up of aluminum plates, filled with some simulated electronics boxes, each of which was installed with a circuit board as the actual payload. "Soft-catch" devices were used to collect the breakup debris. The size and mass distribution curves of collected debris were obtained. It showed that 1) the cumulative number (equal or greater than a given length or given mass) yielded a linear relationship with the debris character length or character mass in logarithmic coordinates, especially for small size debris; 2) the satellite size had a significant influence on the intercepts of the distribution curves and no influence on the curve slopes. Numerical simulations on the satellite breakup were performed using AUTODYN code and SPH method. The breakup process of simple shells and full scale satellite models were studied, at impact velocities of 2km/s to 7km/s and impact angles of 0 degree to 45 degree. Using the numerical data, a relationship between the fragmentation mass and impact conditions including the energy density and the mass in the impact channel was obtained. Based on the realization of satellite breakup physics, a new model named as SBM (Satellite Breakup Model) to describe the size distribution of breakup debris was developed incorporating the experimental and numerical data. This model can describe the breakup degree of satellite quantificationally and give a influence of various factor during breakup process because the satellite size, structural density and fragmentation mass were involved in it.