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

Author: Mr. Kenshou Sugahara
Kyushu Institute of Technology, Japan, h344131k@tobata.isc.kyutech.ac.jp

Prof.Dr. Yasuhiro Akahoshi
Kyushu Institute of Technology, Japan, akaho@mech.kyutech.ac.jp
Mr. Takao Koura
Kyushu Institute of Technology, Japan, koura@mech.kyutech.ac.jp
Dr. Tomohiro Narumi
Kyushu Institute of Technology, Japan, naluminum@gmail.com

INTACT MEASUREMENT OF FRAGMENTS IN EJECTA DUE TO HYPERVELOCITY IMPACT

Abstract

Space debris has been increasing in Earth orbit with the advance of space development in recent years. Therefore a spacecraft is exposed to the risk of impact with orbital debris and micro-meteoroids. The impact of debris or meteoroid causes a generation of secondary debris (ejecta) and damage to a spacecraft, and has a possibility of mission failure and fragmentation.

For a design of reliable spacecrafts, accurate estimation of the frequency and influence of debris impact in space debris environment are necessary. The space agencies of several countries have the space debris environment model which can estimate the debris flux and impact velocity. However, the difference between impact frequencies of each model was seen 100 μm or more and 1 mm or more in the size of debris. The flux of debris in this size range affects the survivability of satellites because the debris impact in the size of 100 μm or more can cause a surface damage of solar array panels and the debris impact in the size of 1 mm can perforate a body of satellites. Moreover, since it is difficult that debris which a size is 1 cm or less detects by an observation from the ground, the amount of debris of this range is uncertain.

It is thought that the cause which minute debris generates is the ejecta when debris impact with a structure. The ejecta consist of different three ejected processes such as small and high velocity fragments (cone ejecta), large and low velocity fragments (spall), very small amount fragments (jetting). The cone ejecta are generated from melted projectile and target. The spalls are the largest fragments and they are emitted by a brittle fracture near free surfaces. The jetting are only less than 1% of total ejected mass, therefore they are neglected.

We conducted hypervelocity impact test in order to obtain a data which can analyze quantitatively the ejecta considered to the error cause of debris environment model. The hypervelocity impact tests were carried out using the Small Two-Stage Light Gas Gun (STSLGG), installed at Laboratory of Spacecraft Environmental Interaction Engineering (La SEINE) in Kyushu Institute of Technology. Multilayer plates of the polystyrene were located in front of the target in order to recover the intact fragments and obtain a size distribution. The velocity of the ejecta was measured using high-speed video camera.