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Considering the gap effect and shape detail for a wire probe antenna subjected to hyper-velocity impacts

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Abstract

We investigated the response of a Wire Probe anTenna (WPT) wire subjected to high-velocity impacts in former paper[1]. The results of numerical simulations adopting these material models were compared with hypervelocity impact tests using a two-stage light-gas gun, and examples of the impacts on a Wire Probe anTenna (WPT) wire were shown. Although only the results using the Lagrangian method were discussed in the paper because of limitations of space, it has been demonstrated that the numerical analysis could effectively simulate the overall corresponding impact test results.

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Keywords: Orbital Debris; Hydrocode AUTODYN; Two-Stage Light Gas Gun; Numerical simulation; space craft

1. Introduction

We have been conducting hypervelocity impact tests and numerical simulations to develop a Japanese spacecraft design guideline for the protection of satellites from a certain degree of micrometeoroids and small-scale orbital space debris (M/OD) impacts [2]. A working group was formed by members of JAXA, spacecraft manufacturers, experts and researchers in the field of hypervelocity impacts to investigate the effects of M/OD impacts on satellite critical parts and bumpers by hypervelocity impact (HVI) tests and analysis. The knowledge acquired is now being reflected in the spacecraft design guidelines. Under those plans, we compared the numerical simulation results with the

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experimental results and investigated the response of a Wire Probe anTenna (WPT) wire subjected to high-velocity impacts.

Numerical simulations were performed by a using hydrocode:ANSYS AUTODYN. The numerical results are compared and discussed with corresponding experimental ones from the viewpoint of the protection assessment of satellites from the M/OD hypervelocity impacts. It has been clarified that material models in the numerical simulation are also discussed and wide range of im-pact velocities, including shock-induced vaporization, are also presented and discussed. As part of this effort, we investigated the response of an WPT wire to high-velocity impacts and compared the results of numerical simulations with impact tests.

Exploration of energization and Radiation in Geospace (ERG) aboard the second Epsilon Launch Vehicle, launched from the Uchinoura Space Center at 8:00 p.m. on December 20, 2016 (JST). Japan Aerospace Exploration Agency (JAXA) has also nicknamed ERG "ARASE". ERG satellite was developed as a science satellite by the Institute of Space and Astronautical Science (ISAS)/ JAXA [3]. ARASE has entered its science operations phase after Mar. 29, 2017. The call was made as the following procedure took place as scheduled and was confirmed; the satellite post launch orbital systems are in place, their functions are determined as fine, all monitoring instruments are installed, and the motions of the monitoring equipment are checked. ARASE is in good condition, with all its onboard apparatus for science observations performing well since activated. Figure 1 show the appearance of the ARASE satellite, which starts a new journey to Van Allen radiation belts, located in the Earth's inner magnetosphere, where energetic charged particles are trapped. The nominal mission life is planned to be longer than 1 year. The satellite is designed to be Sun-oriented and spin-stabilized with a rotation rate of 7.5 rpm (8 s). The designed apogee altitude is 4.5 RE (L ~5.5 at equatorial plane), the perigee altitude is ~300 km and planned orbital inclination is 31°. The satellite will have many chances for the observations near the equator and will measure the phase space density, generation of plasma waves, and accelerations of relativistic electrons, etc., near the equator. Moreover, the off-equator observations are important to discuss the propagation of plasma waves from the equator. Comprehensive observations of plasma/particles, fields, and waves are important for understanding the cross-energy coupling for relativistic electron accelerations and dynamics of space storms. The electric field component is measured by WPT which is two pairs of wire dipole antennas with ~32 m tip-to-tip length.

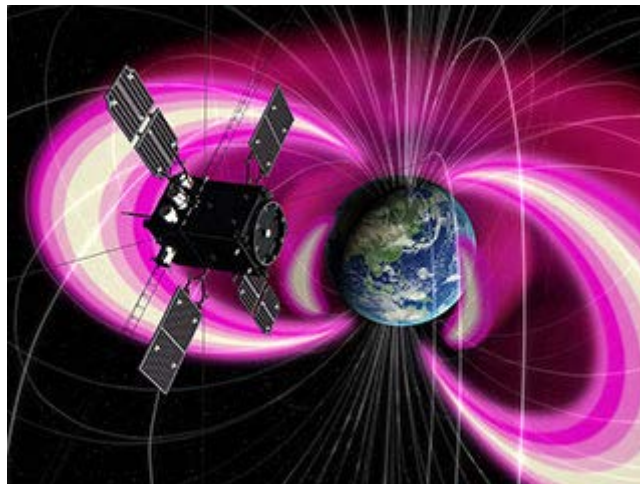


Figure 1. Appearance of the Energization and Radiation in Geospace (ERG:ARASE) satellite.

Nomenclature

u_0	Impact velocity (km/s)
t	thickness of plate (mm)
D	Diameter of Projectile (mm)
d	Diameter of wire

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