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EXPERIMENTAL STUDY ON IN-SITU OBSERVATION TECHNOLOGY AND PROTECTION PERFORMANCE VERIFICATION OF SPACE DEBRIS HIGH-SPEED IMPACT

Abstract

The increasing frequency of human space activities has brought about a sharp increase in the number of space debris, and it is inevitable that spacecraft will be impacted by space debris at high speed. Therefore, how to realize the in-situ observation of high-speed impact of single space debris is the premise of the reappearance of impact scene, and then the design and verification of space protection. In this paper, a space debris acceleration device with controllable speed and size is realized by using a reusable anti-gate structure, gas flow regulator and switch control module. Moreover, single-frame multi-exposure trajectory imaging technology is used to achieve high frame frequency imaging, which is achieved by optimizing the light source channel to provide high frequency light source, and supplemented by low frame rate long exposure industrial cameras with good low light performance, so that the camera can accommodate more flashes in each exposure time. It has been proved that the in-situ observation technology of high-speed impact of space debris can accelerate a single space debris particle with a diameter of 0.5 micron to almost 300 m/s, and can realize more than one million frames per second and the spatial resolution of tens of millions of pixels. The minimum observable target size is less than 10 microns, and the maximum observable speed is in the kilometer level. Finally, the in-situ observation technology of high-speed impact of space debris was used to study the space protection performance of bionic shell materials. It was verified that the impact protection performance of this material against space debris with a particle size of 100 microns was between 235.75m/s and 265.42m/s. This study provides a new method for the microscopic dynamic mechanical characterization and protection performance testing of materials, and further provides a feasible method for the study of various high-speed impact scenarios of space debris, which is conducive to the design of space protection.