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ANALYSIS AND PREDICTION OF END-OF-LIFE PERFORMANCE OF GAAS SOLAR CELL IN INTENSE SPACE RADIATION ENVIRONMENTS

Abstract

The geosynchronous transfer orbit (GTO) and medium earth orbit (MEO) are characterized with an intense radiation environment, mainly composed of a combination of electrons and protons. Exposure to these charged particles typically degrades the electrical performance of solar array, thus limiting the lifetime of the missions. GTO is usually used as the intermediate orbits between the injection orbit and the Geosynchronous Orbit for communication satellites. However the transfer time may last as long as six months for ion thruster with a thrust of several tens of mN, compared to that of several days for a large thrust of thruster. MEO becomes attractive to observation satellite constellation, due to a combination of the capabilities of LEO and GEO satellite systems. Space solar array may be seriously degraded for long time settlement in such orbits. Therefore, to be used in intense space radiation environments, understanding the radiation response of solar cell is extremely important for accurate predictions of the expected mission lifetime. The effects of GTO and MEO radiation environments on the degradation of GaAs cells are investigated to provide the reference for solar array design. The on-ground irradiation experiments were performed to evaluate radiation effects of electrons and protons on these solar cells, and also to provide experimental data for predictions of the cell performances under the space radiation environments. For this cell type I-V characteristics were obtained as a function of radiation fluence using electrons (1.0, 1.5 and 2.0 MeV) and protons (3, 5, 8 and 10 MeV). The prediction results of the performance degradation of the GaAs cells are presented as a function of cell material and cover glass, using the displacement damage dose methodology for analyzing and modeling. This study provides reference data for the design of the GaAs solar array in the intense space radiation environments to ensure the security and reliability of on-orbit spacecrafts.