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DEVELOPMENT OF A LOW-RESISTIVITY DIELECTRIC TO ENHANCE SATELLITE EPDS RELIABILITY

Abstract

Electrical Power and Distribution System (EPDS) is a major system of satellites, whose main function is to provide sustained electrical power to satellites throughout their lifetime. EPDS normally consists of power generation unit (solar array), power transfer unit (solar array drive assembly or cables), power storage unit (battery), and power conditioning distribution unit. The reliability of EPDS is crucial to satellites, because its malfunction may result in the failure of satellites. Dielectrics are widely used in EPDS, especially in its power transfer unit. An example is the dielectric utilized by the slip rings of solar array drive assembly to avoid interference of adjacent power transfer channels. Due to the relatively low conductivity and the related low electron leakage rate of dielectric, once the satellite is surrounded by the space plasma or exposed to space radiation, in-coming particles are prone to accumulate on the surface of dielectric to the point that material breakdown or arcing occurs. To mitigate these detrimental effects, this research is aimed to lower the electricity of the dielectric to avoid the high voltage due to static electricity accumulation, and at the same time maintain its insulation and high voltage withstanding properties. In this paper, the main material properties of dielectric with respect to the satellite on-orbit charging environment were analyzed. The proper range of these properties to reduce the discharging risks was proposed. A formula of the composite dielectric that possesses the desired properties (low electricity and high insulation capability) was determined based on a design of experiment (DOE) method. The validity of the dielectric was proved through the radiation test, the long-term thermal stability test and the simulated space charging test on a solar array drive assembly that utilized this dielectric.