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HIGH-ENERGY RADIATION TESTING AND EFFECTS ON SPACECRAFT MATERIALS OUTGASSING

Abstract

Space exploration missions to the Jovian system are of increasing interest due to the potential for life, or an environment capable of supporting life, in the Jupiter icy moons (Europa, Callisto, and Ganymede). Jupiter has a vast magnetosphere, created by the planet's large magnetic field, protecting the planet and inner moons from the solar wind. Io's active volcanoes are a source of plasma which creates a unique plasma environment. Jupiter's fast rotating magnetic field accelerates particles, creating one of the most intense radiation environments in the Solar System. Missions to the Jovian system pose unique challenges due to the Jovian radiation environment and its effects on flights systems and science instruments. NASA's Jet Propulsion Laboratory (JPL) has developed a unique capability to test high-energy radiation effects on spacecraft materials outgassing in support of missions to the Jovian system. This paper describes the JPL Radiation Induced Outgassing Test (RIOT) facility and discusses results from the initial test campaign. The RIOT facility uses an upgraded Dynamitron particle accelerator as a source of high-energy radiation. Materials samples are mounted in a temperature controlled plate, with active cooling by liquid nitrogen, which can maintain materials samples at the desired flight temperatures. The instrument complement is composed of four Cryogenic Quartz Crystal Microbalances (CQCMs) and a Quadrupole Mass Spectrometer (QMS). The four CQCMs are temperature controlled and can measure condensable outgassing rates at select operating temperatures of spacecraft sensitive surfaces. The Quadrupole Mass Spectrometer is used for characterization of contaminant species and to identify high-energy radiation effects on outgassing effluents. A test campaign was initiated at JPL to evaluate high-energy radiation effects on spacecraft materials in support of science missions to the Jovian system. Initial results show significant effects on certain materials, with outgassing rate enhancements of one to two orders of magnitude. This paper will also discuss select results from the initial test campaign at JPL and demonstrate the importance of high-energy radiation effects to space exploration missions to the Jovian system.