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ATOMIC OXYGEN FACILITY SIMULATING LEO AO ENVIRONMENT FOR MATERIAL EXPOSURE TO UNDERSTAND CHARGING-ARCHING BEHAVIOR OF EXPOSED SURFACE MATERIALS

Abstract

Spacecraft in LEO sweep through a rarefied atmosphere composed primarily of atomic oxygen, whose densities varies with altitude. However, because of high orbital velocity (8 kms-1) of spacecraft, spacecraft surface experience high incident flux (5e15 atoms/m2s) for orbit around 600km of energetic (5eV translational energy) atomic oxygen which affect polymeric surface materials used on spacecraft surface. This AO irradiation changes the surface properties such as secondary electron emission, photo ionization and bulk conductivity of the exposed surface materials. This changing property of surface polymeric materials changes the charging arcing behavior of solar cells used in solar panel of spacecraft for power generation. The risk for this charging arcing phenomenon has got further increased by high voltage power requirement, because of enlargement of spacecraft dimension and lifespan further, which can affect partially or completely spacecraft solar panel causing serious operation and lifetime challenges. A novel technique for generating atomic oxygen flux involves laser induced breakdown of molecular oxygen followed by rapid expansion of recombining plasma, resulting in the production of flux of mono energetic oxygen atoms. We get high velocity AO in an evacuated nozzle where laser beam (from CO2 laser) breakdowns molecular oxygen into atomic oxygen injected through a pressurized pulse valve into the nozzle. The energy of AO is measured using TOF-QMAS technique. GeneratedAO flux is measured using quartz crystal microbalance(QCM) and mass flow controller inserted in oxygen gas supply line. The spectral analysis of AO production wavelength (777.3nm) is detected using spectrometer. The relative abundance of generated species is observed using residual gas analysis (RGA) system. The developed facility produces AO of velocity 10-14 kms-1 having flux in the range of e19 atoms/m2s. AO flux can be further increased by using high frequency (1-8Hz) operation of pulse valve and laser interaction. Thus we are able to reduce the exposure time in days for actual LEO exposure of 10years lifetime of spacecraft. The developed facility will be used for spacecraft surface material exposure and exposed materials parameters will be analyzed for charging arcing test before launch which will increase our scientific understanding of charging behavior for exposed materials.