6-25-2018

Parameterization of Secondary and Backscattered Electron Yields for Spacecraft Charging

Justin Christensen
Utah State University

Phil Lundgreen
Utah State University

JR Dennison
Utah State Univesity

Parameterization of Secondary and Backscattered Electron Yields for Spacecraft Charging

Justin Christensen, Phillip Lundgreen and JR Dennison

Material Physics Group, Physics Department, Utah State University

Abstract

Spacecraft charging codes model the interactions between energetic electrons and spacecraft materials through material properties called electron yields (EY). The accuracy of spacecraft charging calculations can be critically affected by the availability of accurate EY data for materials and by how the measured data are parameterized for use with spacecraft charging codes. This work investigates the effectiveness of various EY fitting models.

Most often total electron yield (TEY) is characterized by two separate parameterized curves, a secondary electron yield (SEY) curve for low-energy emission <50 eV and a backscattered electron yield (BSEY) for high energies >50 eV. Typical semi-empirical models describe the SEY as a function of incident electron energy in terms of material properties such as atomic number, mean excitation energy, electron range, and mean free path. Other purely empirical models use parameters which define the shape of the resulting curves rather than physical material properties. The models are usually presented in reduced form, with yields scaled by the maximum yield δ_{max} and energies scaled by the energy E_{max} at δ_{max}. The complexity of SEY models considered here can be classified by the number of free fitting parameters, beginning with δ_{max} and E_{max} to include a total of 2, 3, 4 or 5 parameters. BSEY models considered include a single-parameter empirical model widely used in most spacecraft charging codes and extended empirical models with 3 and 4 free parameters.

Some electron yield models were found to be more effective than others at approximating the measured yield curves of certain materials or energy ranges; this has been quantified for each of several common spacecraft materials using χ^2 statistical analysis. The implementation of parameterized electron yield models in various spacecraft charging codes is also discussed.