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Electron Yield of Carbon-Composite Nanodielectric Material

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Abstract

Electron irradiation experiments were conducted to investigate the electron yield and emission properties of an epoxy/carbon-fiber composite material. The composite material structure consists of alternating layers of a conducting carbon fiber weave and an insulating epoxy matrix. We discuss how this structure made of both conducting and insulating components influences the electron yield and emission properties of the material. Electron yield measurements were made of both the composite material and bulk samples of the two constituent materials in an ultrahigh vacuum electron emission test chamber, with electron beam energies ranging from 15 eV to 30 keV. Related structural and charging properties were also measured with scanning electron microscopy, energy dispersive x-ray analysis, and cathodoluminescence. Models of the total, secondary and backscatter yields as a function of incident energy are presented. Two limiting cases—a layered model of sheets of conducting and insulating materials and a patch model of adjacent regions of bulk conducting and insulating materials—are used to predict the yield curve of the composite material, along with models combining aspects of both of these limits.