Selfconsistent Electrical Charging in Insulators

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Abstract

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For low energy electron scattering in insulators we have recently developed a Monte Carlo program based on acoustic and optical phonon scattering as well as on impact ionisation of valence band electrons, [1]. This MC version has advantages in description of very low energy electron scattering (in eV and meV regions) aimed especially to wide gap dielectrics and insulators. Thus the rapid relaxation of excited electrons within the conduction band of a wide gap insulator occurs over femtoseconds. The field-dependent transport and trapping parameters allow us to model the selfconsistent charge transport and charging-up of SiO2 andAl2O3 thin layers as well as bulk samples during electron bombardment. The resulting distributions of currents, charges and electric fields within these samples explain e.g. the phenomena of field-enhanced and field-blocked secondary electron emission. In order to prove the accessible quantity of the surface charging-up potential we have chosen the x-ray bremsstrahlung (BS) spectra, i.e., the shift of the short wavelength threshold due to the negative surface potential V0 and respective retarding of the PE beam. This effect is demonstrated for a 3 mm bulk Al2O3 sample and E0 = 30 keV electron beam irradiation resulting in a huge negative surface potential of = -17 kV, [2]. A second experimental method to measure the surface charging potential uses the shift of secondary electron energy distributions. This method is applied predominantly to thin insulating films, e.g. for SiO2 layers in microelectronics, [3].

[1] E. Schreiber, H.-J. Fitting, J. Electron Spectroscopy & Related Phenomena 124 (2002) 25 [2] X. Meyza, D. Goeuriot, C. Guerret-Piecourt, D. Treheux, H.-J. Fitting, J. Appl. Phys. 94 (2003) 5384 5392 [3] I. A. Glavatskikh, V. S. Kortov, H.-J. Fittimg, J. Appl. Phys. 89 (2001) 440