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Dielectric/metal structure: effect of the dielectric thickness on the secondary electron emission

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Secondary and backscattered electron emission from solids submitted to electron-irradiation is of considerable interest in many fields of science and technology: electron beam analyse techniques, electron lithography, study of the behaviour of satellites charging processes in orbit submitted to irradiation, field emission display technologies, Hall effect thrusters. Regardless the specific area of interest, the knowledge of the electron emission yield (EEY) is highly requested. The EEY is the number of emitted electrons (secondary and backscattered) with respect to the incident electrons number. In some applications, low EEY is needed (rf components, spacecraft materials) in others conversely a high yield is needed (electron amplifiers). One interesting approach that could be used to tune the EEY is to coat the material by very thin dielectric layer. Two different techniques were applied for the sample elaboration: (1) thermal growth and (2) plasma deposition process. Very thin SiO₂ layers (up to 100 nm) were thermally grown on highly doped Si-substrates at 1100°C under slightly oxidizing atmosphere using N₂-O₂ gas mixture with 1% O₂. Plasma SiO₂ layers were deposited in the plasma of radiofrequency capacitively coupled discharge sustained at low pressure in a mixture of argon-hexamethyldisiloxane-oxygen (Ar-HMDSO-O₂). The layer thicknesses were measured by spectroscopic ellipsometry. In this work, we show that the thickness of the dielectric layer as well as its microstructure affect significantly the electron emission processes (see Fig 1). Based on our experimental results, we show that this result is mainly due to the sensitivity of the transport of the secondary electron undergoing emission on both the dielectric microstructure and the inner electric field. Practical consequences and potential applications of the presented results will be discussed during the conference.

Figure 1: EEY of SiO₂/Si as function of the incident electron energy at normal incidence and room temperature. Curve 1: 10 nm of thermal SiO₂ and curve 2: 90 nm of thermal SiO₂.

