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UV-enhanced environmental charge compensation

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When measuring dielectric materials by XPS in ambient pressure conditions, the build-up of charge at the surface can be partially eliminated by the so-called environmental charge compensation. The charge compensation is achieved by the electrons resulting from the photoionization of the gas phase. In this work we have explored how to enhance the environmental charge compensation by irradiating the sample simultaneously with UV (HeI, 21.2 eV) photons during the XPS measurement. UV sources, already present in many laboratory-based spectrometers for the performance of UV-photoelectron spectroscopy (UPS), constitute a potentially interesting ionization source, with the ability to provide gas-phase electrons within an energy range of up to some tens of eV. The elevated high cross sections for ionization of UV photons should guarantee higher electronic currents coming from the photoionization of the gas as compared with the illumination with X-rays alone. On the other hand, the large cross section for ionization would also result in higher charge levels at the substrate, so it is not straightforward to predict which of the two effects (higher charge or higher compensating electron current from the gas) would dominate. The final equilibrium achieved at the surface between out-going and in-going currents will depend on several aspects, such as the chemistry of the surface and gas phase, the sample geometry, size of the irradiation beam and photon density, among others. We have illustrated the effect of a combined X-ray and UV irradiation by measuring three types of dielectric samples with different composition and geometries: a meso-porous 3D SiO2 monolith with an irregular surface, a flat mica sample, and thin SiO2 layers deposited onto doped Si wafers. Additionally, we have also explored the relevance of the irradiation spot size for the minimization of differential charging, by itself and in combination with UV irradiation. We will discuss the influence of these parameters in terms of how they affect both lateral and vertical inhomogeneous charging. The effect of gas and sample composition will also be discussed.

if ”Other”, please specify:

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No

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