Image contrast mechanisms in a combined PEEM/LEEM investigation of organic layers on metals

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Organic thin film morphologies and organic-metal interfaces play an important role in the emerging field of organic electronics and optoelectronics. The electronic properties of these systems are largely influenced by film properties like film thickness, roughness, dislocation density, molecular orientation or crystal structure. Due to the polymorphism and variety of structures observed in molecular crystals, the detailed understanding of growth and interface properties requires combined microscopic and spectroscopic investigations like implemented in the SMART spectromicroscope. Especially the (X)PEEM/LEEM methods are dedicated to study organic growth. Although the basic contrast mechanisms of PEEM and LEEM imaging have been often discussed for metal and semiconductor surfaces, no detailed analysis of the organic-metal interfaces is presently available.

The image contrast of Hg-short arc PEEM, x-ray induced PEEM and LEEM imaging of organic layers of PTCDA (and NTCDA) on Ag(111) and Au(111) will be discussed. Surprisingly, the image intensity in Hg-PEEM is not only very sensitive to the work function, but also to the attenuation of the photo-emitted electrons from the substrate in the subsequent organic layers. Interestingly, up to 10 layers of organic material can be resolved with this method. In a different manner, the reflectivity of electrons below 10 eV reveals in LEEM the presence of quantum size effects in the organic film, which implies that mainly the interference between the reflected electron waves from the film-vacuum and the substrate-film interfaces leads to the contrast between the different layers. Work function changes for the different organic thicknesses are further measured from the I(V) curves and correlated to the Hg-PEEM data.

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