Optimizing Organic Thin Films from Microspectroscopic Analysis

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High-resolution near-edge x-ray absorption fine structure (NEXAFS) spectroscopy is ideally suited to investigate the electronic properties of organic molecules. The development of new instrumentation at 3rd generation synchrotron light sources offers both, superior spectral quality in the soft x-ray regime as well as high lateral resolution for spectromicroscopy experiments. Both are without doubt required for detailed insight into the properties of ultrathin organic films (from the submonolayer regime to several 100 monolayers).

In-situ experiments with the presently installed SMART spectromicroscope at BESSY-II will be presented to discuss the influence of the adsorption kinetics on the growth of organic films and their effect on the film morphology. The electric moments (dipole or quadrupole moments) of the molecules may induce metastable (structural, orientational) phases, which can easily be followed during the in-situ observation in PEEM. The influence of steps is evident from the spatially resolved in-situ observation of the film growth. The molecular film grows best under conditions far from thermal equilibrium as will be demonstrated for PTCDA and NTCDA multilayer films adsorbed on Ag(111).

Whereas XPEEM easily allows in-situ detection of organic film growth, scanning transmission x-ray microspectroscopy (STXM) is limited to ex-situ prepared films due to spatial and vacuum restrictions. Deposition from wet cells has not yet been performed. STXM experiments were performed at the ALS concentrated on the morphology, crystallization and spectroscopic properties in ex-situ prepared organic films. The molecular substances were ranging from heteroaromates to magnetic supramolecules. The latter consist of a well-defined number (4 – 8) of paramagnetic ions (Ni, Mn, Co) which are stabilized by an organic ligand shell. Spatially resolved NEXAFS experiments focussed on the oriented growth of these molecules and on their electronic properties. The metal L-edges of the respective transition metals were found to be extremely sensitive to radiation damage. The damage leads to a reduction of the metal ions most likely from electrons excited in the ligand shell.

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