Nonlinear Photoemission Microscopy

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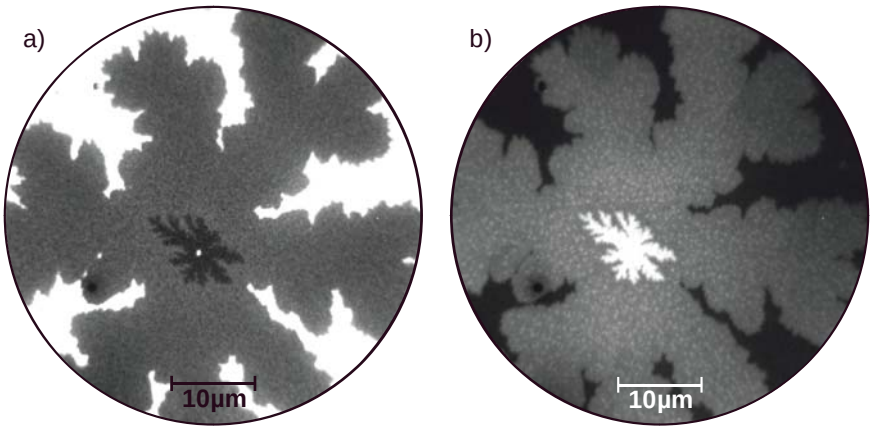
The combination of PEEM with pulsed (femtosecond) laser sources allows the observation of the decay of electronic excitations in thin films with spatial resolution. If the work-function of the material at interest is lower than the energy of the laser pulses, two-photon photoemission can take place. Here, a first photon is used to generate an excitation in the film, while a second photon initiates photoemission. The time-delay between the two (pump and probe) photons then distinguishes between simple Two Photon Photoemission Microscopy that allows characterization of the intermediate state, and Pump-Probe Microscopy that allows to observe the decay of the excited intermediate state.

We used a spectroscopic PEEM (ELMITEC) with a frequency doubled Ti:Sapphire oscillator to study the morphology dependence of the decay of electronic excitations in thin organic layers of Pentacene and Anthracene. Both molecules, if deposited on a Si surface, initially form a wetting layer of flat-lying molecules, while subsequent layers stand upright and develop a typical dendritic shape. The change in morphology is reflected in the decay channels for the electronic excitation: while we determine a time constant of less than 200fs for the decay in the Pentacene wetting layer, the lifetime in the dendritic islands is more than twice as high. Mapping of the lifetime reveals that the excitation decay is in fact different for islands of different height.



PEEM images of Anthrazene islands on Si(111). (a) regular photoemission under illumination with a Hg discharge lamp. (b) two photon photoemission under illumination with fs laser pulses.