Seminář odd. 26
Tenkých vrstev a nanostruktur

Fyzikální ústav AVČR, Cukrovarnická 10, Praha 6

datum: 12. 6. 2012 úterý

čas: 10:00

místnost: knihovna, budova A, 1.p.

TÉMA

Investigations of model organic materials and photovoltaic devices using noncontact atomic force microscopy and Kelvin probe force microscopy

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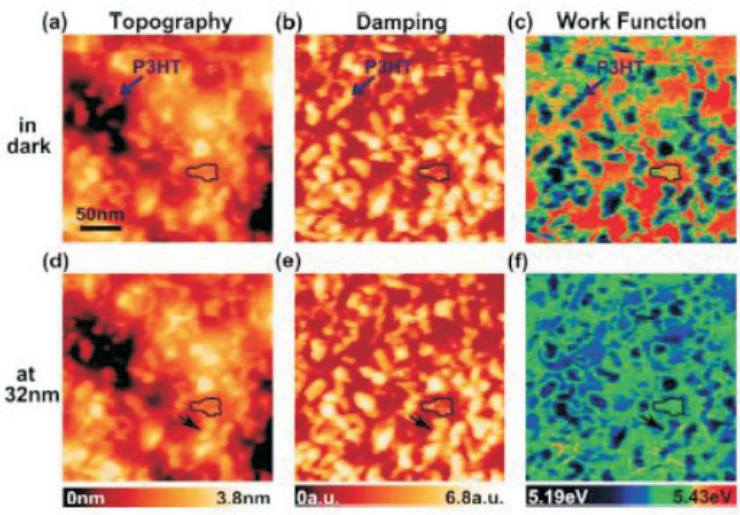
A comprehensive noncontact atomic force microscopy (nc-AFM) and simultaneous Kelvin probe force microscopy (KPFM) investigation, under ultrahigh vacuum, has been performed on three thin-film components of an organic photovoltaic device in order to examine the structure and electronic surface properties at the nanoscale.

First, the active layer of an organic solar cell (OSC), a 100 nm bulk heterojunction (BHJ) blend of poly(3-hexylthiophene) (P3HT) and phenyl-C61-butyric acid methyl ester (PCBM) has been characterized. Amplitude modulated KPFM measurements were performed in dark and under illumination at 532 nm, as seen in the figure below. Local surface contact potential measurements are recorded with a resolution of a few nm. Analysis of the surface photovoltage, obtained from contact potential images, reveals a spatial resolution of the space charge region, where exciton dissociation takes place, at the donor/acceptor interfaces to be no more than ~3 nm.

Next, model self-assembled π-conjugated oligomers have been investigated, in order to obtain a deeper insight into the nature of the tip-surface interactions involved in nc-AFM/KPFM. It is shown that the apparition of a damping contrast characterizes the onset of short range electrostatic (SRE) forces, which are responsible for the occurrence of local CPD (LCPD) modulations correlated with the molecular lattice. By working at the onset of the damping contrast, the tip-surface separation can be adjusted to minimize the contribution of SRE forces to the measured CPD.



Finally, work function values of flexible transparent electrodes, based on functionalized carbon nanotubes using metallic nanoparticles, were obtained by comparative in-situ ultraviolet photoelectron spectroscopy (UPS) and KPFM measurements. It is shown that by appropriate choice of the metal source for functionalization, work function engineering can lead to work function values higher or lower than that for pristine metallic nanotubes. This could be of great interest for adjusting the work function of transparent electrodes to active layers in many optoelectronics devices.

odborný garant: *Ing. Pavel Jelínek, Ph.D.*