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HR-TEM and HR-PES studies of metal nanoparticles in organic molecular thin film

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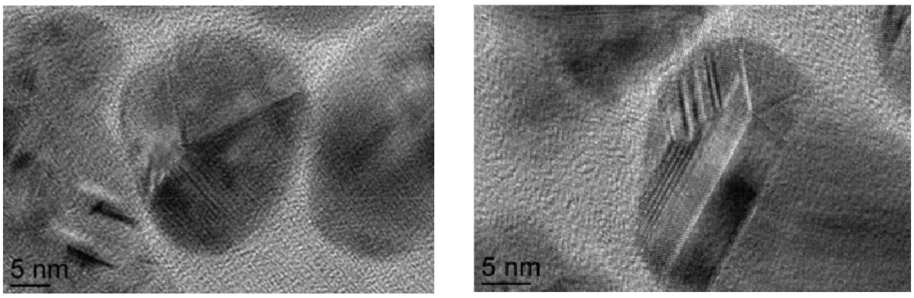
Currently information technology is rapidly penetrating all spheres of our life. Extreme downsizing and the simultaneous increase in productivity require the search for new materials with uncommon properties. Since recent years the research activity has tendency to focus on investigation of advanced materials based on low dimensional systems, which includes in particular hybrid organic-inorganic systems composed of inorganic nanoparticles embedded in an organic semiconductor thin film matrix [1].
The aim of this work was to study hybrid systems consisting of metal nanoparticles (gold, silver and aluminum) embedded in the organic semiconductor $CuPcF_x$, i.e. creation of model of nanocomposite materials and study of their fundamental characteristics [2-6]. The relevance of the work is determined by the need to identify key physical parameters (morphology and electronic properties) for each pair of materials.
Evolution of morphology of hybrid nanocomposite films, depending on the nominal coating was studied by high-resolution transmission electron microscopy (HR-TEM). An analysis of electron microscopic photographs showed that after the metal deposition in ultrahigh vacuum on the surface of the organic semiconductor takes place a process of self-organizing of deposited atoms, which are likely due to the surface and bulk diffusion and join together to form nanoparticles. By HR-TEM the images of metal nanoparticles with direct resolving of atomic planes were obtained. For some coatings the coalescence processes of nanoparticles depending on the initial mutual orientation of the nanoparticles was observed.
The electronic structure and alignment of the energy levels at the interfaces formed between the metal nanoparticles and an organic semiconductor, and chemical reaction at these interfaces were studied at room temperature by high-resolution photoelectron spectroscopy (HR-PES) using synchrotron radiation. Part of the research was carried out on a new dynamic X-ray photoemission (Fast-XPS) station, which is intended for research of advanced materials in in-situ mode in real time (data acquisition about 0.1 sec/spectrum), built in the P04 beamline of synchrotron PETRA III (DESY, Hamburg).

This cycle of investigations with observation of some new phenomena may lead to opening up opportunities for a range of new applications.



(a) (b)

Figure 1: Microstructure of nanocomposite thin films consisted of silver nano-particles embedded in CuPc matrix (HR-TEM) with nominal Ag deposition 5.7 nm. Magnifications are indicated by insert marks (a,b).

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