IAP Seminar

Jiří Novák

Central European Institute of Technology
and Masaryk University,
Brno/Czech Republic

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TU Wien, Institut für Angewandte Physik, E134
1040 Wien, Wiedner Hauptstraße 8-10
Yellow Tower „B“, 5th floor, SEM.R. DB gelb 05 B

Watching Organic Semiconductor Films Grow and Melt – an X-ray View

Organic semiconductor (OSM) thin films play an important role in new low cost energy saving devices including organic light emitting diodes, organic solar cells, and organic thin film transistors. The optical and electric performance of the devices is closely related to the crystal structure of the organic layers and to the morphology of organic/organic and organic/inorganic interfaces. X-ray scattering techniques are efficient tools for studying structure and morphology of the films in situ in real time during growth and solvent or thermal treatment.
After a short introduction to the field of OSMs, I will present results of combined synchrotron grazing incidence small angle scattering (GISAXS) and X-ray reflectivity (XRR) real-time studies of growth of thin films of prototypical OSM molecules diindenoperylene (DIP) and buckminsterfullerene (C60) on on Si/SiOx and mica(001) surfaces, respectively. For DIP, the experimental data allow us to follow a transition from a transient thin film crystal to the bulk crystal DIP phase during the growth accompanied by a transition from the layer-by-layer to the island forming growth mode. Applying the thin film growth theory to obtained island size evolution during growth gives us access to island nucleation energies. Moreover, combining experimental data acquired during C60 growth on mica(001) with kinetic Monte Carlo simulations allows even determination of binding energies between C60 molecules, of their surface diffusion barrier, and of the Ehrlich-Schwöbel barrier.
In the second part of the talk, we show results of an home laboratory in situ X-ray diffraction (XRD) study of annealing induced changes in thin films of 5,11-bis(triethyl silylethynyl) anthradithiophene (TES-ADT). TES-ADT is a high charge carrier mobility OSM showing a rich phase-behaviour. The phase transitions are, however, accompanied by strong drops in charge carrier mobility. The XRD experiments allow us to identify determine constants of the β phase and thermal dependence of the lattice constants of the α phase. Surprisingly, we found that the phase transition from the α to the β phase takes place only for films thicker than a critical thickness of about 75 nm, while for thinner films is the α phase transforms to the amorphous melt phase at the transition temperature of 129 °C. Additionally, the α to β phase transition takes place in two steps via an intermediate amorphous phase for the thick films. We will discuss possible causes for this so far unreported behaviour.

Jiří Novák joined postgraduate studies of semiconductor and solid state physics at JKU Linz and Masaryk University Brno (Czech Republic) (under double supervision), defending thesis in 2006. Thereafter, he worked as a post-doctoral fellow at the European Synchrotron Radiation Facility (2006 –2009), TU Graz (2009 – 2011), and University of Tübingen (Germany) (2011 – 2013). In 2013, J. Novák joined a newly established research institute CEITEC and Masaryk University in Brno as a researcher and teacher.

All interested colleagues are welcome to this seminar lecture (45 min. presentation followed by discussion).

Friedrich Aumayr
(LVA-Leiter)

Ulrike Diebold
(Seminar Chair)