

DS 3: Organic Thin Films

Time: Monday 14:30–16:00

Location: H 2013

DS 3.1 Mon 14:30 H 2013

Grain-boundary evolution in a pentacene monolayer — •JIAN ZHANG, JÜRGEN P. RABE, and NORBERT KOCH — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstrasse 15, D-12489 Berlin

Significant charge carrier trapping defects were shown to exist at grain boundaries (GBs) in polycrystalline pentacene films, and these GBs are the principal bottleneck for charge transport in organic thin-film transistors (OTFTs) and they also affect the overall lifetime of OTFTs. In order to better comprehend the growth of organic polycrystalline films and controlling the number of grain boundaries in these films, the formation and evolution of GBs in pentacene films has to be understood. In this work, the evolution of GBs in the first pentacene layer on SiO₂ substrates was studied. Using transverse shear microscopy, we directly observed GBs within single pentacene topographical islands. These intra-island GBs form at very early stages of pentacene film growth (in the present case at a coverage of 0.05 ML). Consequently, the existence of GBs within single pentacene islands (not visible in height images) will complicate "single-grain" transport measurements. During island growth the intra-island GB density increases linearly, suggesting a continued formation of new grain boundaries also before islands coalesce. Additionally, post-fabrication thermal annealing can reduce the GB density significantly in the pentacene layer in direct contact with SiO₂, which should lead to a considerable decrease of charge carrier trapping sites in OTFTs.

DS 3.2 Mon 14:45 H 2013

In-situ growth studies of the organic semiconductors perfluoro-pentacene, pentacene, and diindenoperylene — •STEFAN KOWARIK¹, ALEXANDER GERLACH¹, ALEXANDER HINDERHOFER¹, FRANK SCHREIBER¹, TUSHAR DESAI², SUKWON HONG², ARAM AMASSIAN², and JAMES R. ENGSTROM² — ¹Universität Tübingen, Germany — ²Cornell University, Ithaca, USA

We present x-ray data from real-time and in-situ growth monitoring for the molecule perfluoro-pentacene (PFP, an n-type semiconductor) and compare it to real-time growth-data for the popular systems pentacene (PEN, p-type) and diindenoperylene (DIP, p-type). For organic molecular beam deposition (OMBD) of PFP we show that 3d-growth sets in after two monolayers, i.e. earlier than for PEN and DIP which exhibit favorable layer-by-layer growth up to four and eight monolayers, respectively. In comparison to PEN and DIP which can exhibit coexistence of crystal structures within the temperature range of 10 - 70 °C, we find the PFP film structure to be very similar to its bulk structure and not compromised by occurrence of phase coexistence. Extending the possibilities of OMBD through deposition at hyperthermal energies, we show for the example of DIP that supersonic deposition of molecules can increase the in-plane island size.

DS 3.3 Mon 15:00 H 2013

Mixing and phase-separation in co-deposited films of rod-like conjugated molecules — •JÖRN-OLIVER VOGEL¹, RICARDA OPITZ¹, INGO SALZMANN¹, STEFFEN DUHM¹, BERT NICKEL², JÜRGEN RABE¹, and NORBERT KOCH¹ — ¹Humboldt-Universität zu Berlin, Berlin, Deutschland — ²Ludwig-Maximilians-Universität, München, Deutschland

Pairs of rod-like conjugated molecular materials [sexithiophene (6T), p-sexiphenyl (6P), dihexylsexithiophene (DH6T), quaterthiophene (4T), and pentacene] were co-deposited by organic molecular beam deposition on silicon oxide. We studied the properties of thin film samples by atomic force microscopy (AFM), X-ray diffraction (XRD), and infrared spectroscopy (IR). The co-deposition of pairs of molecules with similarly sized conjugated cores (e.g., 6T/6P) resulted in layered structures with mutual intercalation of the molecules. In contrast, co-deposition of molecules with differently sized conjugated cores led to two different morphologies: (i) Pairs of non-alkylated molecules (e.g., 4T/6P) formed fibrous amorphous films. (ii) Pairs of alkylated and non-alkylated molecules (e.g., DH6T/4T) exhibited phase separation with crystalline structures comparable to the ones of the pure materials. Our results suggest that a similar size of the conjugated cores of two co-deposited molecular materials is a key prerequisite for the formation of layered structures with mutual intercalation of the molecules.

The particular type of the conjugated molecular moiety seems not to play an important role.

DS 3.4 Mon 15:15 H 2013

Growth and characterization of thin films prepared from $F_{64}Pc$, a new class of organic molecular semiconductors — •CHRISTOPHER KEIL¹, OLGA TSARYOVA², SERGIU M. GORUN², DIETER WÖHRLE³, OLAF R. HILD⁴, and DERCK SCHLETTWEIN¹ — ¹Institut für Angewandte Physik, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, D-35394 Gießen, Germany — ²Department of Chemistry and Environmental Science, New Jersey Institute of Technology, University Heights, Newark, New Jersey 07102-1982, USA — ³Institut für Organische und Makromolekulare Chemie, Universität Bremen, Leobener Strasse NW 2, D- 28334 Bremen, Germany — ⁴Fraunhofer IPMS, Maria-Reiche-Str. 2, D-01445 Dresden, Germany

Thin films of the zinc, copper or vanadium-oxo complexes of $F_{64}Pc$, a perfluoro(isopropyl)phthalocyanine were prepared by physical vapor deposition in vacuum. Electrical conduction and optical transmission measurements were performed during the deposition of films to analyze the formation of conducting pathways, the mechanism of film growth and intermolecular electronic coupling. Transmission spectra of the films to a large extent resembled those of solutions of the molecules speaking in favor of widely decoupled molecules. A low extent of intermolecular electronic coupling was also concluded from the small specific conductivity $10^{-11} - 10^{-9} \text{ S cm}^{-1}$. A further decreasing specific conductivity upon exposure to air confirmed the n-type characteristics expected from the strongly electron- withdrawing characteristics of the perfluoro- alkyl substituents. The potential to apply this new class of molecular semiconductor materials in devices is discussed.

DS 3.5 Mon 15:30 H 2013

Morphological and electrical characterisation of discotic liquid crystals thin films — •ANNALISA CALÒ¹, PABLO STOLIAR¹, MASSIMILIANO CAVALLINI¹, YVES HENRI GEERTS², and FABIO BISCARINI¹ — ¹CNR-ISMN, Via Gobetti 101 Bologna (BO) 40129 Italy — ²ULB, Laboratoire de Chimie des Polymères, CP 206/1, Boulevard du Triomphe, Brussels 1050 Belgium

In this work we study the correlation between the morphology and the electrical transport on thin films of H₂Pc(OC₁₄,10)₄. Here we present a comprehensive morphological characterisation by means of both cross-polarisers optical microscopy (O.M.) and atomic force microscopy (AFM) changing the temperature across the different phases, i.e. columnar rectangular, columnar hexagonal, and melted phase. These microscopic techniques also provide information about the films stability depending on the interactions with the surface. We developed an in-situ experimental setup to obtain the electrical characterisation contemporary with the morphological study in order to study how the electrical transport relates to the molecular aggregation.

DS 3.6 Mon 15:45 H 2013

Quantitative evaluation of the anisotropy of the optical constants of phthalocyanine thin films — •MICHAEL FRONK, DIETRICH R.T. ZAHN, and GEORGETA SALVAN — Physics Department, Chemnitz University of technology, D-09107 Chemnitz

In this work copper phthalocyanine films prepared by organic molecular beam deposition on silicon substrates with thicknesses of about 60 nm are investigated by means of variable angle spectroscopic ellipsometry (VASE) and reflection anisotropy spectroscopy (RAS). The ellipsometry results indicate an uniaxial symmetry of the organic films with the uniform optical constants in the film plane different from those out of plane. RAS shows in addition the presence of an in-plane optical anisotropy in the order of 10^{-3} to 10^{-2} that is too small to be detected by ellipsometry. The RAS data is analysed using the layer model "air - film - substrate". Considering that the incident light is composed of two parts polarised linearly parallel to the main axes of the in-plane anisotropy we calculate the difference of the optical constants of the organic film along the two axes. This allows to estimate the degree of preferential orientation of the molecules within the film plane.