DS 46: Organic Thin Films III

Time: Friday 14:00–16:15 Location: H8

DS 46.1 Fri 14:00 H8

Role of the substrate in electronic structure, molecular orientation, and morphology of organic thin films: diindenoperylene on rutile TiO2(110) — •Maria Benedetta Casu, Britt-Elfriede Schuster, Indro Biswas, and Thomas Chassé — IPTC, University of Tübingen, Tübingen, Germany

Diindenoperylene (DIP, $C_{32}H_{16}$) is a perylene-based molecule that shows a very high hole mobility already in thin films, good film forming properties, and thermal stability. Sample preparation and photoemission experiments (X-ray photoelectron spectroscopy, XPS) were carried out in an ultrahigh vacuum system, The Ti 2p core level photoemission spectrum showed only a very weak low binding energy shoulder usually attributed to surface non-stoichiometry due to oxygen vacancies (3-5 % in our clean substrates). Atomic force microscopy (AFM) measurements were performed under ambient conditions in tapping mode. Near edge X-ray absorption spectroscopy (NEXAFS) measurements were performed at the beamline UE52-PGM at BESSY (Berlin). The results of our multitechnique investigation performed on diindenoperylene thin films deposited on rutile TiO_2(110) show island growth, with crystallites nucleating preferentially along the [1-10] substrate crystallographic axis. The findings evidence that the film properties at the interface are common to what found for a number of organic molecules deposited on the same substrate, revealing that the structural and morphological properties of organic thin films on rutile TiO_2(110) are essentially driven by its surface topography, with its rows of bridging oxygen atoms, while the molecular properties are less relevant.

DS 46.2 Fri 14:15 H8

Luminescence of PTCDA monolayers on NaCl in relation to their structural properties — •Mathias Müller, Eric Le Moal, Oliver Bauer, and Moritz Sokolowski — Institut für Physikalische u. Theoretische Chemie, Universität Bonn, Wegelerstraße 12, 53115 Bonn

On insulating surfaces the luminescence of monolayers of organic molecules can be studied in detail whereas on metals the luminescence is suppressed in most cases. The use of thin epitaxial NaCl(100) films grown on Ag(100) enabled us to perform spot profile analysis-LEED parallel to in-situ photoluminescence spectroscopy. Under optimized evaporation conditions we obtain different PTCDA monolayer structures, namely a commensurate 3x3 superstructure, an incommensurate herringbone-structure, and a disordered phase. All phases have interesting photoluminesce properties with sharp peaks and a well resolved vibronic finestructure in common. Besides, their luminescence spectra differ significantly in their energetic positions. Calculations based on a point-dipole model show that the corresponding exciton band structures have to be described by J-aggregates. This allows to explain the observed energetic differences of the luminescence spectra of these phases in detail. Funding by DFG research unit 557 is gratefully acknowledged.

DS 46.3 Fri 14:30 H8

Standing and lying α-6T molecules probed by PEEM spectroscopy — •Thorsten Wagner, Daniel Roman Fritz, Martin Oehzelt, and Peter Zeppenfeld — Johannes Kepler University Linz, Institute of Experimental Physics, Austria

The growth of α-sexithiophene (α-6T) depends strongly on the quality of the substrate surface: If the surface is clean and well ordered, the molecules are flat lying on the surface and form characteristic needles. If the surface is disordered, they grow in a upright standing manner forming platelet like crystallites [1]. We have applied photoelectron emission microscopy (PEEM) to study the growth of α-6T films on Ag(110) at different temperatures. By using a Hg-lamp with a photon energy of 4.9 eV it is not possible to overcome the ionization threshold of the molecule itself. Therefore, thick films of the molecules do not emit photoelectrons themselves but absorb these emitted from the metal substrate. Due to the coupling to the metallic substrate the first wetting layer shows an increased PEEM intensity. By applying high energy light sources available in the lab (D_2 with 6.4 eV and HeI with 21.2 eV) one can overcome the ionization potential and actually probe photoelectrons originating from the organic film. As the PEEM also allows energy filtering of the images, it is possible to probe the density of states on a 50 nm scale. The data reveal different emission spectra for the needles and the platelet like crystallites due to the orientation of the molecules in agreement with Duhn and Ivanco [1].

[1] S. Duhm *et al.*, Nature Materials **7**, 326 (2008) and J. Ivanco *et al.*, Surf. Sci. **601**, 178-187 (2007)

DS 46.4 Fri 14:45 H8

Energy level alignment at sexithiophene-fullerene heterojunctions from photoelectron spectroscopy: differentiating between intrinsic and extrinsic energy shifts — •Raphael Schlesinger[1], Hendrik Glowatzki[1], Johannes Frisch[1], Ralf-Peter Blum[1], Patrick Amsalem[1], Antje Vollmer[2], Jürgen P. Rabe[1], and Norbert Koch[1] — [1]Humboldt-Universität zu Berlin, Institut für Physik, 12489 Berlin, Germany — [2]HZB-Bessy II Albert-Einstein-Straße 15, 12489 Berlin, Germany

Ultraviolet photoelectron spectroscopy (UPS) was used to study the electronic structure of heterojunctions of sexithiophene (6T) and C_{60} on Au, Ag, and PEDT:PSS. Our results suggest that a monolayer of 6T on PEDT:PSS is lying flat, while molecules in multilayers stand vertically upright. The highest occupied molecular orbital (HOMO) of the 6T monolayer is less than 0.2 eV below the Fermi-level, while for multilayer 6T films the HOMO is pinned at 0.4 eV below the Fermi-level. This difference in binding energy of the frontier 6T levels is attributed to a charge-exchange reaction between 6T and PEDT:PSS, which is confined to the 6T monolayer only. The energy level alignment at the C_{60}/6T interface is found to follow the vacuum level alignment model. We will further highlight that effects often assigned to band bending in organic molecule films may well be induced by the UPS measurement itself. 6T films on PEDT:PSS exhibited a non-reversible shift of the energy levels/work function to higher binding energies by up to ca. 0.5 eV as a function of illumination with ultraviolet light (UV) that is commonly used to excite photoelectrons in UPS experiments.

DS 46.5 Fri 15:00 H8

Structural order of perfluoropentacene in fiber-textured and expitaxial films on amorphous and single crystalline substrates — •Ingo Salzmann[1], Martin Oehzelt[2], Steffen Duhm[1], Bernhard Wedl[3], Dmitrii Nabok[4], Jürgen P. Rabe[1], and Norbert Koch[1] — [1]Humboldt Universität zu Berlin, Germany — [2]Johannes Kepler Universität Linz, Austria — [3]Technische Universität Graz, Austria — [4]Montanuniversität Leoben, Austria

Synchrotron X-ray diffraction reciprocal space mapping (RSM) was performed on fiber-textured perfluoropentacene (PFP) thin films on SiO_x to determine the crystal structure of a monoclinic thin-film phase [1]. In a recent study, the growth of PFP on Ag(111) was investigated by X-ray standing waves and specular X-ray scattering reporting a flat adsorption geometry within the monolayer and a structural transition to an unknown (lying) herringbone structure upon subsequent growth [2]. We demonstrate an approach to solve unknown thin-film polymorphs on single crystalline substrates through a combination of RSM, X-ray diffraction pole figure technique (XRD-PF) and an appropriate variable substrate choice. Taking advantage of both the fiber-texture of Highly Ordered Pyrolytic Graphite (HOPG) and the low surface roughness we determined a structure solution of the triclinic polymorph of PFP/HOPG by RSM and proved the same to be present on Ag(111), Au(111) and Cu(111) by XRD-PF deriving the epitaxial relationships to the substrates.

[1] I. Salzmann et al., Langmuir, 24, 7294 (2008)

[2] S. Duhm et al., submitted.

DS 46.6 Fri 15:15 H8

template induced area selective growth: control over patterning of organic semiconductors — •Wenchong Wang, Dingyong Zhong, Chuan Du, Harald Fuchs, and Lifeng Chi — Physikalisches Institut and Center for Nanotechnology (CeNTech), Universität Münster, 48149 Münster, Germany

Functional small-molecular-weight organic molecules have received great scientific and technological interest due to their promising applications in electronics and optoelectronics. However, their future success in applications will strongly depend on the fabrication processes that include feasible methods for patterning. Here we present two strategies for area selective growth of organic molecules based on different mechanisms, namely binding-energy-difference-induced and step-edge-induced growth. Molecules may prefer to nucleate on material with which molecules have larger binding energy from other area when diffuse on pre-patterned substrate. Fully uniform nucleation control at the predefined locations can be achieved by an appropriate selection of the growth parameters and template dimensions. Molecules can also be controlled to nucleate at the edge of the template first, and grow laterally due to strong interaction such as π-π interaction of aromatic molecules, resulting in area selective growth of molecules on topographically low area of substrate. The technique can be used to grow crack-free, crystalline films with large domain sizes, presenting significantly increased charge mobility in comparison with un-patterned substrates. Further more, the two mechanisms can be combined together to separate molecules at defined locations.

DS 46.7 Fri 15:30 H8

Coverage and Morphology Dependence of Dip Coated Organic Films on Withdrawal Velocity — •Tomás Corrales[1,2], Pía Homm[2], Piero Ferrari[2], María J. Retamal[2], Edgardo A. Cisternas[3,2], Valeria del Campo[4,2], and Ulrich G. Volkmann[2] — [1]Max-Planck-Institut für Polymerforschung, Mainz, Germany — [2]Dept. of Physics, P. Universidad Católica de Chile, Santiago de Chile — [3]Dept. of Research and Development, Tecnología Integral S.A., Santiago de Chile — [4]Dept. of Hydraulic and Environmental Engineering, P. Universidad Católica de Chile, Santiago de Chile

In this work we dip-coat n-dotriacontane onto silicon substrates, coated with their native oxide film (≈15 Å), from an n-heptane solution varying systematically the withdrawal velocity from 0.04 cm/min to 9.25 cm/min. After coating, we study the resulting films with AFM and SEM. We observe the formation of self-assembled monolayer structures with different coverage and morphologies, depending on the withdrawal velocity: For a pulling velocity of 1 cm/min we observe a minimum coverage of ≈11% while a maximum coverage of ≈54% is reached for the slowest velocity (0.04 cm/min). For velocities higher than 5 cm/min we observe a stabilization at a coverage of ≈35%. We relate this behavior to the transition from a gravity driven film growth to an entrained film regime, proposed by M. Ghosh et al. [1]. We also find that the morphology of these structures depends strongly on the withdrawal velocity.

[1] M. Ghosh, F. Fan, K.J. Stebe, Langmuir 23 (4), 2007.

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DS 46.8 Fri 15:45 H8

Thin films of new organic charge transfer systems — •Milan Rudloff and Michael Huth — Physikalisches Institut, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main

We deal with the preparation and characterization of thin films of organic charge transfer (CT) systems. These systems are made of donor and acceptor molecules that exhibit an additional electrostatic attraction due to Coulomb interaction between donor and acceptor. The electronic properties of the resulting new compound (depending on crystal structure, temperature and pressure) can be those of an insulator, a semiconductor, a metal or a superconductor.

The thin films are prepared by organic molecular beam deposition (OMBD). The OMBD process takes place inside an UHV chamber in which the source materials are (co-) sublimed and deposited onto a substrate. After that the samples are characterized by light and atomic force microscopy, X-ray diffractometry and (temperature dependent) transport measurements.

Our work focuses on new donor-acceptor combinations with the aim to prepare CT compounds that are yet unknown. The results presented here relate to experiments with some of these new donor(D)-acceptor(A) pairs, e.g. tetramethoxypyrene (D) + tetracyanoquinodimethane (A) and tetrathiafulvalene (D) + tetraketopyrene (A).

DS 46.9 Fri 16:00 H8

Direct Write 3-Dimensional Nanopatterning using Probes — •Felix Holzner[1], Armin Knoll[1], David Pires[1], Ute Drechsler[1], Michel Despont[1], Heiko Wolf[1], James Hedrick[2], Anuja DeSilva[3], and Urs Duerig[1] — [1]IBM Research - Zurich, Switzerland — [2]IBM Research - Almaden, USA — [3]IBM Research - Watson, USA

A high-resolution probe based patterning method is presented using organic resists, that respond to the presence of a hot tip by local material desorption. Thereby arbitrarily shaped patterns can be written in the organic films in the form of a topographic relief. Line gratings with a half-pitch of 15 nm have been fabricated.

Moreover, three dimensional patterns can be written by controlling the amount of material removal. The patterns can be readily transferred into silicon using standard RIE technology. The new technique offers a cost-effective and competitive alternative to high-resolution electron-beam lithography in terms of both resolution and speed.