DS 15: Organic Thin Films, Organic-Inorganic Interfaces

Time: Friday 9:30–11:45 Location: H3

Invited Talk DS 15.1 Fri 9:30 H3

Structure formation and growth at the metal-organic interface — •Peter Zeppenfeld — Institute of Experimental Physics, Johannes Kepler University Linz, Austria

The evolution of the structural, electronic and optical properties of organic thin films strongly depend on the ordering, aggregation and orientation of the molecules within the very first or a few deposited monolayers. The chosen substrate and its intentional modification (e.g. by pre-adsorption of inorganic or organic species) may thus have a strong influence on the structural, electronic and optical properties of the growing organic thin film. Using complementary experimental methods, namely, surface optical spectroscopy (RDS, DRS), diffraction (LEED) and microscopy (STM, PEEM), supported by empirical models and ab-initio calculations we aim to identify (and eventually quantify) the underlying driving forces. We will present examples on the 2D condensation of organic molecules on metal surfaces, the structural and orientational ordering in 2D (and quasi 1D) monolayer phases and its influence on the further growth of the organic thin film. Finally, we will illustrate the effects of modification / templating of the substrate on the structure and properties of the organic layers.

DS 15.2 Fri 10:00 H3

Thin film heterostructures based on Co/Ni synthetic antiferromagnets on polymer tapes: towards a sustainable flexible spintronics — •Mariam Hassan[1], Sara Laureti[2], Christian Rinaldi[3], Federico Fagiani[3], Gianni Barucca[4], Manfred Albrecht[5], and Gaspare Varvaro[2] — [1]Institute of Physics, TU Chemnitz, Germany — [2]CNR-ISM, nM2-Lab, Italy — [3]Department of Physics, Politecnico di Milano, Italy — [4]Università Politecnica delle Marche, Dipartimento SIMAU, Italy — [5]Institute of Physics, University of Augsburg, Germany

The PGMs-free Co/Ni-system offers several advantages for spin-based devices such as low damping and high spin polarization, and they contribute to a more sustainable future. Moreover, these films could be good substrates for the investigation of the chiral-induced spin selectivity ”CISS” effect. In this work, flexible synthetic-antiferromagnets with perpendicular-magnetic-anisotropy (PMA-SAFs) and GMR-spin-valves (SVs) containing a SAF-reference electrode and a Co/Ni-free layer were deposited on flexible polyethylene naphthalate tapes with different combinations of buffer and capping layers (Pt, Pd, Cu/Ta). High-quality SAFs with a fully compensated antiferromagnetic region and SVs with a sizeable GMR ratio were obtained. The best performances are achieved with PGMs used as buffer layer and Cu as capping layer[1]. The results indicate that complex Co/Ni-based heterostructures with reduced content of PGMs deposited on flexible tapes allow for the development of novel shapeable and sustainable spintronic devices. [1]ACS Appl. Mater. Interfaces. 14 (2022) 51496-51509.

DS 15.3 Fri 10:15 H3

highly crystalline, cleavable, and transferable semi-conducting 2D imine COF film — •diksha srivastava[1], vipin mishra[2], showkat h. mir[3], jyotirban dey[1], jayant k. singh[1], manabendra chandra[1], and thiruvancheril g. gopakumar[1] — [1]Indian Institute of Technology Kanpur, Kanpur 208016, India — [2]KU Leuven, Celestijnenlaan 200F, Leuven B-3001, Belgium — [3]University of Kashmir, Hazratbal, Srinagar 190006, Jammu and Kashmir, India

Two-dimensional (2D) imine-based covalent organic frameworks (COFs) are emerging crystalline organic polymers with potential applications in thin-film electronics, sensing, and catalysis, driven by their stability, tunable electronic properties, and versatile functionality. We present a scalable method for synthesizing 2D imine-COF films on dielectric glass substrates via a Schiff base reaction between p-phenylenediamine (PDA) and benzene-1,3,5-tricarboxaldehyde (TCA) over 15 hours. This yields highly crystalline 2D networks with film thicknesses ranging from 100 nm to a few monolayers and lateral dimensions up to 2 cm. Sonication exfoliation is employed for producing free-standing films. Structural characterization via SEM, TEM, and AFM confirms highly crystalline 2D structures. XPS analysis validates the chemical composition, while optical measurements indicate a semi-conducting band gap. DFT calculations show a semiconductor-like band structure with strong band dispersion near the conduction and valence band edges, signifying efficient charge transport and potential for future electronic applications.

session break

DS 15.4 Fri 10:45 H3

Excited state dynamics in thin films of planar and twisted azaperopyrene derivatives — •Jakob Steidel[1], Robert Eichelmann[2], Jakob Sawatzki[1], Lutz Gade[2], and Petra Tegeder[1] — [1]Physikalisch-Chemisches Institut — [2]Anorganisch-Chemisches Institut, Universität Heidelberg, Germany

Azaperopyrene derivatives are a class of organic semiconductors with a high potential for applications in optoelectronic devices. The molecular π-system of planar octaazaperopyrenedioxide (OAPPDO-H) is substituted with chlorine yielding OAPPDO-Cl, a molecule with a twisted structure.

In this contribution we utilised transient absorption spectroscopy to elucidate excited state dynamics of OAPPDO derivatives with planar and twisted molecular π-systems in thin films. On a short time scale of several hundred femtoseconds we observed fast population of excited states and fluorescence in both materials. The lifetimes of these processes show a similar dependency on the intensity of the excitation pulse. On a long time scale of several nanoseconds striking differences were observed. While the lifetimes of the excited state in OAPPDO-Cl increased and saturated with increasing excitation intensity, the lifetimes in OAPPDO-H showed a maximum at a medium excitation intensity of 400 nJ per pulse. We assign this behaviour to the opening of an additional decay pathway due to triplet-triplet-annihilation that requires cofacial arrangement of two molecules. Only planar OAPPDO-H can arrange in such a way, while the increased steric hindrance in OAPPDO-Cl suppresses this intermolecular interaction.

DS 15.5 Fri 11:00 H3

Thermally Tuning the Optical Properties of Discrete NDI-T2 Oligomer Thin Films — •Alexander Ehm[1], Fabian Eller[2], Meike Kuhn[2], Rukiya Matsidik[1], Michael Sommer[1], Eva M. Herzig[2], and Dietrich R. T. Zahn[1] — [1]Faculty of Natural Sciences, Technische Universität Chemnitz, D-09107 Chemnitz, Germany — [2]Dynamik und Strukturbildung - Herzig Group, Universität Bayreuth, Universitätsstr. 30, D-95447 Bayreuth, Germany

In the pursuit of developing and optimizing n-type organic semiconductors for the use in organic electronics, materials derived from naphthalene diimide (NDI) and bithiophene (T2), such as P(NDI2OD-T2), are highly interesting [1]. Changing the average molecular orientation via thermal annealing, and thereby their opto-electronic properties, allows finetuning for specific applications [2].

Recently, we showed that the optical anisotropy of the discrete oligomers NDI-(T2-NDI)2 and T2-(NDI-T2)2 can be influenced by thermal annealing [3]. Here, we extend this study and reveal that the photoluminescence and optical anisotropy, as found by variable-angle spectroscopic ellipsometry of T2-(NDI-T2)2 can be continuously tuned by the choice of the annealing temperature. The correlation with molecular alignment is investigated using grazing-incidence wide-angle X-ray scattering.

[1] Chen et al. J. Am. Chem. Soc. 2009, 131, 8
[2] Vu et al. ACS Macro Lett. 2023, 12, 140
[3] Ehm et al. Phys. Status Solidi B Basic Res. 2024, 2400202

DS 15.6 Fri 11:15 H3

Highly-Robust Double Neuromorphic Device Based on Perovskite/Molybdenum Oxide-Sulfide Compound Heterojunction — •Gion Kalemai[1,2], Michael-Alexandros Kourtis[3], Anastasia Soultati[1], Apostolos Verykios[1], Dimitris Davazoglou[1], and Maria Vasilopoulou[1] — [1]Institute of Nanoscience and Nanotechnology (INN) National Center for Scientific Research Demokritos, Agia Paraskevi, Athens, Greece — [2]Department of Physics, University of Patras, Patra Rio, Greece — [3]Institute of Informatics & Telecommunications, National Center for Scientific Research Demokritos, Agia Paraskevi, Athens, Greece

This study addresses the fundamental perovskite memristor limitations by integrating a robust molybdenum oxide-sulfide (MoO3-MoS2) mixed layer beneath a RbCsMAFA quadruple cation perovskite, precisely engineered through sulfurization of sub-stoichiometric MoO3-x.

The resulting neuromorphic device exhibits impressive RS, with an ON-OFF ratio of 100, high retention & endurance, and a 0.5sec switching speed. Analysis confirm the successful control in the MoO3-MoS2 structure, which introduces trap states within the bandgap, facilitating SCLC and enabling robust memory function.

The composite, demonstrates enhanced synaptic emulation capabilities, such as PPF-PPD, and STP-LTP, replicating key synaptic functions for neuromorphic computing. Notably, this device offers excellent stability under 85°C, an enhanced ON-OFF ratio under illumination. Thus, the potential of sub-stoichiometrically engineered architectures is underlined.

DS 15.7 Fri 11:30 H3

Spatially resolved work-function manipulation of azobenzene-functionalized self-assembled monolayers by optical stimulation — Jan Böhnke[1], Beatrice Andres[1], Larissa Boie[1,2], Angela Richter[1], Cornelius Gahl[1], Martin Weinelt[1], and •Wibke Bronsch[1,3] — [1]Freie Universität Berlin, Fachbereich Physik, Arnimallee 14, 14195 Berlin, Germany — [2]Paul Scherrer Institut, Forschungsstrasse 111, 5232 Villigen, Switzerland — [3]Elettra-Sincrotrone Trieste S.C.p.A., Strada Statale 14-km 163.5 in AREA Science Park, 34149 Basovizza, Trieste, Italy

Strongly differing static dipole moments of the trans and cis isomers of photochromic azobenzene allow for optical work-function switching of azobenzene-functionalized self-assembled monolayers (SAMs) [1,2]. We apply these properties in a fundamental experiment to manipulate the area size of the switched SAM [3]. In our experiments we spatially resolve the transient isomerization profile of the SAM after UV illumination by means of photoemission electron microscopy imaging. We demonstrate the capability of spatial tuning of the SAM's work function and discuss the role of the laser spot profile in generating sharp edges or gradual changes of the work function across the sample.

[1] Bronsch et al., Appl. Phys. Lett. 111, 081601 (2017).
[2] Bronsch et al., J. Phys.: Condens. Matter 29, 484002 (2017).
[3] Böhnke et al., Appl. Phys. Lett. 124, 191601 (2024).