

CPP 47: Poster: Interfaces and Thin Films

Time: Wednesday 18:15–21:00

Location: Poster B2

CPP 47.1 Wed 18:15 Poster B2

Metal ions at metal/polymer interfaces — ●MARIA SONNENBERG¹, RENÉ GUSTUS¹, WOLFGANG MAUS-FRIEDRICH¹, HERBERT SCHEERER², JUAN PABLO VEGA TRIANA², SASCHA SEDELMEIER³, and JÜRGEN WIESER³ — ¹Clausthaler Zentrum für Materialtechnik, Agricolastraße 2, 38678 Clausthal-Zellerfeld, Germany — ²Zentrum für Konstruktionswerkstoffe, Grafenstraße 2, 64382 Darmstadt, Germany — ³Fraunhofer LBF, Schlossgartenstraße 6, 64289 Darmstadt, Germany

Understanding the interaction between thin polymer films and metal surfaces is necessary for the plastics processing industry. During the processing of plastic, polymer is melted in the extruder unit. Often thin polymer layers are formed on the surface of the extruder, which leads to peeling off of partly solidified polymer into the melt. These polymer particles will not melt again and generate weak points within the product. Basic understanding of these mechanisms is important in order to avoid steel/polymer interaction. For this purpose thin layers of polycarbonate were prepared by bottom up procedures on different metal substrates and heated up to 280°C. The interfaces were examined by electron spectroscopic (XPS, AES) and microscopic (SEM, AFM) techniques. Experiments show that the diffusion of iron ions in the polymer melt occurs. Same characteristics could not be found for thin polymer layers on chromium substrate. Further experimental results and a mechanism of iron diffusion in thin polymer layers will be shown.

CPP 47.2 Wed 18:15 Poster B2

Mesostructured ZnO scattering layers for OLED applications — ●LORENZ BIESSMANN¹, CHRISTOPH J. SCHAFER¹, JOHANNES SCHLIPP¹, VOLKER KÖRSTGENS¹, SIGRID BERNSTORFF², and PETER MÜLLER-BUSCHBAUM¹ — ¹TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching, Germany — ²Elettra Sincrotrone Trieste, 34012 Basovizza, Italy

By now the internal quantum efficiency of organic light-emitting diodes (OLEDs) reached values close to 1 but the overall efficiency still suffers on the extraction of the photons from the device. For further improvements of the performance one can apply a scattering layer to the device. Besides the direct structuring of the substrate surface, the attachment of a transparent layer on the substrate is a very promising approach. With an optical band gap of 3.3 eV, ZnO is a suitable material for this method. In this work ZnO is used as an additional layer on a glass substrate to achieve scattering abilities. For this purpose a structure giving diblock copolymer template was combined with sol-gel chemistry for tailoring the ZnO scattering layer. This yields thin mesostructured films. The film morphology as probed by scattering techniques and SEM is related to the spectral response to gain a structure-function relationship.

CPP 47.3 Wed 18:15 Poster B2

Molecular dynamics of itraconazole confined in thin supported layers — ●EMMANUEL URANDU MAPESA¹, MAGDALENA TARNACKA², EWA KAMIŃSKA², WILHEM KOSSACK¹, MARTIN TRESS¹, WYCLIFFE KIPNUSU¹, KAMIL KAMIŃSKI², and FRIEDRICH KREMER¹ — ¹Institute for Experimental Physics I, University of Leipzig, Linnestr. 5, 04103, Leipzig, Germany. — ²Institute of Physics, University of Silesia, ul. Uniwersytecka 4, 40-007 Katowice, Poland.

Broadband Dielectric Spectroscopy (BDS) is used to study the molecular dynamics of thin layers of itraconazole - an active pharmaceutical ingredient with rod-like structure and whose Differential Scanning Calorimetry (DSC) scans reveal liquid crystalline-like phase transitions. It is found that (i) the structural relaxation process remains bulk like, within the limits of experimental accuracy, in its mean relaxation rate, while (ii) its shape is governed by two competing events: interfacial interactions, and crystalline ordering. Additionally, (iii) the dynamics of the delta-relaxation - assigned to the flip-flop rotation of the molecule about its short axis - deviates from bulk behaviour as the glass transition is approached for the confined material. These observations are rationalized within the framework of molecular dynamics as currently understood.

CPP 47.4 Wed 18:15 Poster B2

Artificial nanostructuring of thin conjugated polymer films —

●ALI ÖZKÜ, FRANZISKA LÖHRER, and PETER MÜLLER-BUSCHBAUM — TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching, Germany

Conjugated polymer films have received great attention due to many applications in organic electronics, as for example organic solar cells. In particular, novel low band gap polymers have shown to give rise to high power conversion efficiencies. An artificial nanostructuring of the polymer films can add an additional benefit with regard to applications, as for example the photon management can be tailored. In the present work, we combine low band gap polymers with an artificial nanostructuring of the polymer film by soft embossing methods. The optical properties of nanostructured thin films are investigated with UV/Vis and photoluminescence measurements. Morphological studies include optical microscopy, AFM and X-ray diffraction methods. From a combination of these findings, we aim on establishing a structure-function relationship.

CPP 47.5 Wed 18:15 Poster B2

Degradation in printed polymer:fullerene thin films for organic photovoltaics — ●JAN RICHARD STOCKHAUSEN, CHRISTOPH J. SCHAFER, and PETER MÜLLER-BUSCHBAUM — TU München, Physik-Department, James Franck-Str. 1, 85748 Garching

In comparison to conventional silicon solar cells, organic solar cells offer several advantages, such as ease of production in large-scale and high versatility. Nevertheless, their lifetime needs to be prolonged, so that a profitable application on a large-scale becomes feasible. Therefore a detailed understanding of all degradation mechanisms is necessary. In the present investigation we address UV and visible light induced aging of P3HT:PCBM active layers. Instead of spin coating, positive shim mask guided slot dye coating is used for film fabrication as large-scale production will most probably rely on printing techniques. Therefore several irradiation chambers are built to expose the films to radiation of different wavelengths. Changes in the films due to accelerated aging are investigated by means of AFM, X-ray reflectivity and UV/Visible light spectroscopy.

CPP 47.6 Wed 18:15 Poster B2

Thin P3HT:PCBM films with embedded magnetic nanoparticles — ●FLORIAN DREHER, DANIEL MOSEGUÍ GONZÁLEZ, and PETER MÜLLER-BUSCHBAUM — TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching, Germany

Among the different photoactive systems studied in organic solar cells, the combination of P3HT:PCBM has been most prominent due to easy chemical synthesis and, thus, commercial availability. In order to further increase the device performance, doping with magnetic nanoparticles had shown interesting behavior as the device efficiency can be increased upon nanoparticle addition.[1] In the present study we focus on thin P3HT:PCBM films and investigate the impact of different concentrations of magnetic nanoparticles under various processing conditions. The film morphology is probed with SEM, AFM and scattering techniques. UVvis spectroscopy and photoluminescence measurements complement these morphology studies. In combination with device characterization we gain a structure-function relationship for these thin hybrid films.

[1] Moseguí González et al.; Adv. Energy Mater. 5, 1401770 (2015)

CPP 47.7 Wed 18:15 Poster B2

Athermal Azobenzene-Based Nanoimprint Lithography — ●CHRISTOPH MEICHNER¹, LOTHAR KADOR¹, CHRISTIAN PROBST², KLAUS KREGER², CHRISTIAN NEUBER², and HANS-WERNER SCHMIDT² — ¹University of Bayreuth, Institute of Physics and Bayreuth Institute of Macromolecular Research (BIMF), 95440 Bayreuth, Germany — ²University of Bayreuth, Macromolecular Chemistry I and Bayreuth Institute of Macromolecular Research (BIMF), 95440 Bayreuth, Germany

We present athermal micro- and nanoimprint lithography as a new method, using a photoresponsive azobenzene-based molecular glass as resist material. Patterning with this approach is based on athermal photofluidization, i.e., a photoinduced decrease in viscosity far below the T_g of the material, enabling mass transport at ambient conditions during light irradiation. In contrast to common imprint techniques, no crosslinking or curing steps are involved. The method is capable of

patterning nanostructures without being limited to periodic structures or the dimension of the light wavelength. Our investigation includes the presentation of the basic principle and the characterization of influencing factors such as wavelength and fluence of the light and film thickness. Micrometer-sized structures of 100 nm height can be imprinted within approximately 200 s. The feasibility of imprinting very precise structure replica down to 100 nm line width is demonstrated. It is found that decreasing structure sizes lead to increased filling times.

CPP 47.8 Wed 18:15 Poster B2

The formation of micro-porous structure in different polystyrene-based polymers — ●FARID FARAJOLLAHI, MASOUD AMIRKHANI, and OTHMAR MARTI — Institute of Experimental Physics, University of Ulm, 89069 Ulm, Germany

Breath figure technique is a self-assembly method to produce porous structure on the surface of polymers under the humid condition. The water condensation creates several small droplets, which can be used as templates to make the porous structure after drying the polymer. Generally, hydrophobic polymers such as polystyrene cannot form the close-packed porous pattern in most cases. Here, we developed a new strategy to employ several polystyrene-based polymers to make porous honeycomb structures. The proper concentration of methanol in the polymer solution can improve the stability of water droplets during porous pattern formation. The effect of polymer molecular weight and monocarboxy end terminated group in the morphology of the patterns are investigated by the scanning electron microscopy. In addition, Voronoi diagram is utilized to compare the regularity of the different patterns. Finally, the viscosity measurement is performed to find the relation between pattern morphologies and the initial viscosity of the solutions.

CPP 47.9 Wed 18:15 Poster B2

Towards 3d single particle orbit tracking in multiblock copolymer membranes — ●DANIEL ZALAMI¹, OLIVER GRIMM², FELIX H. SCHACHER², JÜRGEN KÖHLER¹, and UWE GERKEN¹ — ¹Experimental Physics IV and Bayreuth Institute of Macromolecular Research (BIMF), University of Bayreuth, Germany — ²Institute for Organic Chemistry and Macromolecular Chemistry (IOMC) and Jena Centre of Soft Matter (JCSM), Friedrich-Schiller University Jena

The method of *single particle orbit tracking* (SPOT) permits to record the trajectories of fluorescent particles in three dimensions for long observation times (up to tens of minutes) [1,2]. This versatile technique can be applied in the field of life sciences as well as in the materials chemistry. We want to investigate the diffusion behavior of tracer particles within different block copolymer membranes with a stimuli-responsive block covering the pore surface [2]. Our aim is to address changes in the trans-membrane and intra-membrane transport parameters as a function of the particle properties or variations of the environmental conditions.

[1] V. Levi, Q. Ruan, E. Gratton, *Biophys. J.*, 88, 2919-2928 (2005)

[2] D. Ernst, S. Hain, J. Köhler, *J. Opt. Soc. Am. A*, 29, 1277-1287 (2012)

[3] F. Schacher, M. Ulbricht, A. H. E. Müller, *Adv. Funct. Mater.* 19, 1040-1045 (2009)

CPP 47.10 Wed 18:15 Poster B2

Force response of actively deformed polymer microdroplets and -films: dependence on the solid/liquid boundary condition — ●JONAS R. HEPPE^{1,2}, JOSHUA D. MCGRAW^{2,3}, ROLAND BENNEWITZ¹, and KARIN JACOBS² — ¹INM - Leibniz Institute for New Materials, D-66123 Saarbrücken — ²Saarland University, Experimental Physics, D-66041 Saarbrücken — ³Ecole Normale Supérieure, Département de Physique, F-75005, Paris

In fluid dynamics, the solid/liquid boundary condition can play a major role in the flow behavior of a liquid. For example, in the dewetting of identical polymer films on weak slip or strong slip substrates, large qualitative and quantitative differences are observed. Therefore, when applying an external load to a liquid resting on such substrates, the measured reaction forces and the ensuing flow should also depend on the boundary condition. We present atomic force microscopy measurements in which the reaction force of a cantilever is measured as the tip pierces micron-sized droplets and films of polymeric liquid. These indentations are done on substrates with tuned slip. Accessing the size, depth and rate dependence of the resulting force distance curves, we show an influence of the slip condition on the dissipated energy and adhesion.

CPP 47.11 Wed 18:15 Poster B2

Morphological changes in diblock copolymer thin films in solvent vapor mixtures — ●FLORIAN JUNG¹, ANATOLY V. BEREZKIN¹, DETLEF-M. SMILGIES², DORTHE POSSELT³, and CHRISTINE M. PAPADAKIS¹ — ¹Technische Universität München, Physik-Department, Garching, Germany — ²Cornell University, CHESS Wilson Lab, Ithaca, NY, U.S.A. — ³Roskilde University, Department of Science, Systems and Models, Denmark

Block copolymers self-assemble and form various morphologies. Thin films have been proposed for nanolithography. Solvent vapor annealing increases the mobility of the polymers, which can lead to an improved long-range order. In the present work, solvent vapor annealing was carried out using a mixture of vapors of two different solvents that both are selective for one block. Thin films from a cylinder-forming polystyrene-block-poly(dimethylsiloxane) diblock copolymer were prepared on Si wafers. The morphological changes were investigated by in-situ, real-time grazing-incidence small-angle X-ray scattering, varying the degree of swelling of the film, the mixing ratio of the two solvent vapors and temperature. Varying the solvent vapor composition systematically reveals a path dependence of the resulting morphology.

CPP 47.12 Wed 18:15 Poster B2

Diffusion measurements on organic coatings with cantilever beam deflection method — ●FRANZISKA ROSENSTEINER and SABINE HILD — Johannes Kepler University, Linz, Austria

Organic coatings are used to protect steel bands from corrosion which is important i.e. in the building industry. To enhance the barrier properties of organic coatings to achieve better quality of the product improved knowledge about the influence of glass transition temperature T_g and water diffusion properties is necessary. A climatic chamber equipped with a cantilever beam deflection set-up has been developed and built which enables to control and regulate temperature and humidity simultaneously. As samples coated steel band cut into cantilever (4.5 mm x 0.5 mm) are used which are fixed in a special sample holder. Due to the different expansion coefficient of steel and the polymer coating used varying temperatures and humidity lead to characteristic bending of the cantilever due to internal stresses. The cantilever bending is monitored using an optical deflection sensor. From the resulting deflection curves characteristic values such as T_g , as well as the water diffusion constant can be determined. Besides, the way how water diffuses through the coating may explain details about its barrier properties. Therefore, in addition to the cantilever beam deflection measurements the passway of the water adsorbed from the gaseous and liquid phase inside the coating is analysed with confocal Raman microscopy.

CPP 47.13 Wed 18:15 Poster B2

Dielectric properties of water in carbon nanotubes — ●PHILIP LOCHE, ALEXANDER SCHLAICH, and ROLAND R. NETZ — Freie Universität Berlin, Fachbereich Physik, Arnimallee 14 14195 Berlin

Dielectric properties of confined fluids are important for understanding elementary processes in nanofluids and nanochemistry. Especially cylindrical geometries are of great interest because their applications cover transport through membrane proteins, desalination via nanopores, or transport processes in carbon nanotubes (CNT).

We use Molecular Dynamics Simulations to investigate the dielectric properties of SPC/E water confined in CNTs as model for cylindrical cavities. Comparing various radii and lengths, our results show a high anisotropy. Additionally, we perform a finite size scaling of the influence of the nanotube length and compare to the expectation of simple arguments of statistical mechanics.

CPP 47.14 Wed 18:15 Poster B2

Adsorption of acid-hydrolysed soy protein on hydrophobic surfaces studied with x-ray reflectivity — PAUL SALMEN¹, JULIA NASE¹, ●STEFFEN BIEDER¹, PATRICK DEGEN², YURY FOROV¹, LENA HEUCHEL¹, FLORIAN WIRKERT¹, MICHAEL PAULUS¹, and METIN TOLAN¹ — ¹Fakultät Physik/DELTA, Technische Universität Dortmund, 44221 Dortmund, Germany — ²Physikalische Chemie 2, Technische Universität Dortmund, 44221 Dortmund, Germany

The adsorption of denatured or fragmented proteins is important for many applications in industry and biology. We investigated the adsorption of soy sauce and acid hydrolyzed soy protein on hydrophobic, octadecyltrichlorosilane coated silicon wafers and at the air/water interface with x-ray reflectivity. For acid hydrolyzed soy protein, a concentration dependent adsorption is visible at both interfaces. The

adsorbed layers have a thickness in the nm range and change the surface properties, like wettability and contact angle, strongly. Also, we were able to show that the amount of adsorbed protein fragments is correlated with the hydrophobicity of the interfaces.

CPP 47.15 Wed 18:15 Poster B2

Ausrichtung von Farbstoffmolekülen in vertreckten Polypropylenfilmen — ●MARTIN SCHINDLER, STEFAN KRAUSE, CHRISTIAN VON BORCZYKOWSKI und ROBERT MAGERLE — Fakultät für Naturwissenschaften, Technische Universität Chemnitz, Germany

Die Fluoreszenzpolarisierung von Farbstoffmolekülen ist eine empfindliche Sonde für die Orientierung der Farbstoffmoleküle in einem Polymerfilm. Wir untersuchten mittels Fluoreszenzpolarisationsmikroskopie das Reorientierungs- und Relaxationsverhalten funktionalisierter Perilenbisimidmolekülen in Polypropylenfilmen als Funktion der Dehnung des Polymerfilms, der mit einem Mikrozugversuch uniaxial verstrekt wird. Aufgrund der Sphärolithmorphologie des teilkristallinen Polypropylens erwarten wir ein räumlich heterogenes Verhalten: An den amorphen Grenzen zwischen den Sphärolithen erfolgt eine große lokale Dehnung. Die in diesen Bereichen eingebetteten PBI-Moleküle sollten eine größere Ausrichtung entlang der Dehnungsrichtung aufweisen als in Sphärolithen eingebaute PBI-Moleküle.

CPP 47.16 Wed 18:15 Poster B2

Human apolipoprotein A1 at water - solid and water - gas interfaces — ●SUSANNE DOGAN¹, MICHAEL PAULUS¹, IRENA KIESEL², and PAUL SALMEN¹ — ¹Fakultät Physik/DELTA, TU Dortmund, 44221 Dortmund, Germany — ²Institut Laue-Langevin, 71 avenue des Martyrs, 38000 Grenoble, France

The adsorption behaviour of human apolipoprotein A1 (Apo A1) at hydrophilic and hydrophobic interfaces was studied by means of X-ray reflectometry. Apo A1 is a transport protein and part of the high density protein (HDL) which is responsible for the transport of lipids, mainly cholesterol from the cell membranes to the liver. Due to its anisotropic surface, Apo A1 is able to interact with surfaces or interfaces via different interaction mechanisms including the hydrophobic and electrostatic interaction. pH dependent measurements at the solid - water interface between silicon dioxide and aqueous protein solution show that in a small pH range between pH 3 and pH 5 adsorption is increased due to electrostatic attraction. Here the native shape of the protein is altered, in order to maximize the contact with the interface. In contrast, the strong hydrophobic interaction between the protein and the liquid-gas interface yields the denaturation of the protein.

CPP 47.17 Wed 18:15 Poster B2

Oxidation behavior of $\text{Si}_x\text{H}_y\text{N}_z$ films prepared via plasma-enhanced chemical vapor deposition — ●SEBASTIAN DAHLE^{1,2}, JAN-STEFAN PETERS^{1,2}, and WOLFGANG MAUS-FRIEDRICHS^{1,2} — ¹Clausthaler Zentrum für Materialtechnik, Technische Universität Clausthal, Leibnizstr. 9, 38678 Clausthal-Zellerfeld, Germany — ²Institut für Energieforschung und Physikalische Technologien, Technische Universität Clausthal, Leibnizstr. 4, D-38678 Clausthal-Zellerfeld, Germany

Abstract: The deposition of silicon-containing films is possible in a very simple manner via plasma-enhanced chemical vapor deposition (PECVD). A dielectric barrier discharge (DBD) plasma was used to prepare $\text{Si}_x\text{H}_y\text{N}_z$ films from 1.5% monosilane (SiH_4) diluted in nitrogen. These films were easily transformed into stoichiometric silicon dioxide (SiO_2) by a second DBD treatment in either oxygen or air. Further, the $\text{Si}_x\text{H}_y\text{N}_z$ films were sensitive to atmospheric air even without plasma excitation, although a simple exposure to air was not able to completely transform it into stoichiometric SiO_2 . However, the morphology of the resulting silicon oxide (SiO_x) films severely depended on the pressure and the gas used to oxidize the PECVD primer films.

CPP 47.18 Wed 18:15 Poster B2

Molecular Structure of Photo-switchable Azo Dye/Surfactant Mixtures at Air-Water Interfaces — ●SASKIA STREUBEL, FELIX

SCHULZE-ZACHAU, and BJÖRN BRAUNSCHWEIG — Friedrich-Alexander University Erlangen-Nürnberg (FAU), Institute of Particle Technology (LFG), Erlangen, Germany

Adsorption and molecular structure of disodium 6-hydroxy-5-[(4-sulphophenyl)azo]-2-naphthalenesulfonate (Sunset Yellow) dye mixtures with cetyltrimethylammonium bromide (CTAB) surfactants was studied at air/water interfaces using tensiometry, ellipsometry and vibrational sum-frequency generation (SFG). In addition to effects of the mixing ratio on interfacial adsorption, we have investigated in detail the influence of light-induced isomerization of Sunset Yellow dye and its complexes with CTA^- ions on the molecular structure at air/water interface. Here, different isomers were generated by irradiating the samples with UV light which leads to less-hydrophobic cis-isomers, while backward transformation to trans-isomers could be achieved by blue light. In addition to information on interfacial composition, conformation and charging state that was gained by applying SFG spectroscopy and ellipsometry, we have investigated the properties of macroscopic foam as a function of mixing ratio and UV light exposure and deduce structure-property relations from the molecular to the macroscopic level.

CPP 47.19 Wed 18:15 Poster B2

Dose and energy dependent chemical modification of ultrathin polymer films as studied by STXM — MARKUS MEYER¹, ANDREAS SPÄTH¹, BENJAMIN WATTS², and ●RAINER H. FINK¹ — ¹FAU Erlangen-Nürnberg, PC II, Erlangen, Germany — ²SwissLight Source, Paul Scherrer Institut, Villigen, Switzerland

Organic molecules are very sensitive to intense UV or XUV irradiation which may induce severe chemical modifications. We have employed scanning transmission x-ray microspectroscopy to investigate the influences of photon energy, photon flux and illumination sequence (for different energies) to explore effects like mass loss (due to bond rupture) or chemical changes. In our studies we investigate ultrathin free-standing films of poly-methyl methacrylate (PMMA), polylactic acid (PLA) and polystyrene (PS). The aims specifically focus on the impact of secondary electrons after near-threshold, on-resonance and high-energy irradiation (30 or 100 eV above resonance). It is found that the absorbed dose as a common criterion for induced damage does not necessarily correlate with the observed chemical damage. We conclude a destabilization of respective bonds due to resonant excitation, thus resulting in a higher probability of subsequent bond cleavage and simultaneous formation of new species. Kinetic studies comparing resonant and non-resonant excitations and degradation processes of the chemical structure complete the studies. Profound understanding of mechanisms in the interplay of irradiation with soft matter, allow to prevent and avoid sample degradation and in particular cases take advantage of the introduced, controlled chemical modification.

CPP 47.20 Wed 18:15 Poster B2

Comparison of the Swelling behavior of thin cross-and non-crosslinked ethylene glycol based polymer film — ●JESSICA HÜBNER, DIKRAN KESAL, STEFAN WELLERT, and REGINE VON KLITZING — Stranski Laboratorium f. Physikalische und Theoretische Chemie, TU Berlin, Str. d. 17. Juni 124, Berlin 10623, Germany

Two intensively studied classes of coatings are polymer brushes and layers of microgel particles at planar solid surfaces. Brushes are polymers, tethered at one end to the substrate while microgels are colloidal particles with an inner polymer network structure based on chemical cross-linking. Here, we compare the properties of ethylene glycol based brushes and microgel particles at silicon surfaces in terms of their swelling/deswelling behavior and volume phase transition temperature depending on comonomer content and synthesis conditions. For both systems the monomer was 2-(2-Methoxy-ethoxy)ethyl methacrylate and the comonomer Poly(ethylene glycol)methyl ether methacrylate. In both architectures, the volume phase transition temperature can be tailored by changing the amount of comonomer. Beside ellipsometry also AFM measurements under ambient conditions and in the water swollen state were used to characterize the brushes and microgels.