CPP 37: Interfaces and Thin Films and Responsive and Adaptive Systems

Time: Thursday 10:30–13:00 Location: H39

Invited Talk CPP 37.1 Thu 10:30 H39

Non-equilibrium Properties of Thin Polymer Films — •Günter Reiter[1] and Sivasurender Chandran[2] — [1]Physikalisches Institut, Albert-Ludwigs Universität Freiburg — [2]Department of Physics, Indian Institute of Technology Kanpur, Uttar Pradesh 208016, India

Rapid industrial processes often freeze polymers in non-equilibrium conformations, which, in turn, cause material properties that are significantly different from the predictions of equilibrium theories. Thus, by choosing appropriate processing pathways, we potentially can control macroscopic properties and performance of polymers. However, due to our current lack of fundamental understanding of the behavior of non-equilibrated polymers, we have to rely on empirical knowledge, imposing trial-and-error approaches for achieving desired properties. Considering these aspects, we discuss recent studies on polymer films revealing that quantitative relations exist between properties and processing pathways, suggesting possible relations for processing-induced deviations in chain conformations. These relations propose that long-living and long-ranged correlations between polymers have been induced by processing, as indicated by the observation of relaxation times much longer than known for equilibrated polymers. We present an example where control of processing conditions for thin films allowed to translate the molecular relaxations during equilibration into a predictable lifting of macroscopic loads.

CPP 37.2 Thu 11:00 H39

Water Induced Polymer Reorientation at a Polystyrene/ Polyacrylic Acid Surface — Xiaomei Li[1], Mirela Encheva[2], Kaloian Koynov[1], Hans-Jürgen Butt[1], Ellen Backus[2], and •Rüdiger Berger[1] — [1]Max Planck Institute for Polymer Research, 55128 Mainz, Germany — [2]University of Vienna, Währinger Straße 42, 1090 Vienna, Austria

Polymers are capable of undergoing adaptation phenomena triggered by exposure to liquids. Here we study the adaptation of copolymer films formed by polystyrene and polyacrylic acid (PS/PAA) after water exposure. We measured the dynamic advancing and receding contact angles (CA) of water drops sliding down a PS/PAA film. We associate the gradual increase in advancing CA with drop velocity to the adaptation process to water. By applying adaptation theory, we estimated the time constant of this adaptation process to be much smaller than 1 s. The changes in contact angles may be caused by swelling of the copolymer and/or by a reorientation of the hydrophilic segments (PAA) towards the surface. Therefore, we performed vibrational sum frequency generation (SFG) spectroscopy which is surface sensitive. SFG experiments before and after exposing the copolymer to water reveal a decrease in intensity of the vibrational band representing the PS segments, suggesting a reorientation of the polymer groups at the surface upon contact with water.

15 min. break

CPP 37.3 Thu 11:30 H39

Tailoring the Optical Properties of Sputter-Deposited Gold Nanostructures on Nanostructured TiO2 Templates based on in situ GISAXS Determined Growth Laws — •Suzhe Liang[1], Wei Chen[1], Shanshan Yin[1], Simon J. Schaper[1], Jonas Drewes[2], Niko Carstens[2], Thomas Strunskus[2], Franz Faupel[2], Marc Gensch[1,3], Matthias Schwartzkopf[3], Stenphan V. Roth[3,4], Ya-Jun Cheng[5], and Peter Müller-Buschbaum[1,6] — [1]TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching — [2]LS Materialverbunde, Institut für Materialwissenschaft, CAU, 24143 Kiel — [3]DESY, 22607 Hamburg — [4]Department of Fibre and Polymer Technology, KTH, SE-100 44 Stockholm, Sweden — [5]NIMTE, CAS, 315201 Ningbo, China — [6]MLZ, TU München, 85748 Garching

Au/TiO2 nanohybrid materials have attracted significant attention due to the outstanding optical, photocatalytic and photovoltaic performance. We use customized polymer templating to achieve TiO2 nanostructures with different morphologies. Au/TiO2 hybrid thin films are fabricated by sputter deposition, meanwhile in situ GISAXS during the deposition process is applied to in-depth understand the Au morphology on the TiO2 templates. The resulting Au nanostructure is largely influenced by the TiO2 template morphology. Based on the detailed understanding of the Au growth process, characteristic distances can be selected to achieve tailored Au nanostructures at different Au loadings. For selected sputter-deposited Au/TiO2 hybrid thin films, the optical response with a tailored localized surface plasmon resonance is demonstrated.

CPP 37.4 Thu 11:45 H39

Investigations of ultra-thin film behavior of polycarbonate on inorganic surfaces — •Hassan Omar, Paulina Szymoniak, and Andreas Schönhals — Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany

Thin polymer films are of vital importance due to their low production costs and wide range of applications in sensors, electronics, and coatings. Their geometry is ideal for the study of confinement effects on the thermodynamic properties and segmental dynamics of polymers. However, there is little research into these effects for main chain polymers such as polycarbonate (PC). PC has important applications due to its improved mechanical, optical, and thermal stability compared to other polymers. For this investigation, films of PC ranging from 200 nm to 7 nm were prepared on both glass and silica substrates to measure the dielectric and calorimetric behavior. The methodology consisted of broadband dielectric spectroscopy (BDS), ellipsometry, atomic force microscopy (AFM), and sum frequency generation (SFG). Using ellipsometry, the glass transition was shown to increase with decreasing film thickness. This was further proved by BDS for glassy dynamics for thin films employing different sample geometries (crossed electrode and nanostructured capacitors). The properties and influence of the adsorbed layer on the molecular mobility was also addressed by a combination of AFM, SFG and BDS.

CPP 37.5 Thu 12:00 H39

Fabrication and Characterization of Hydrophobic Porous Metallic Membranes for High-Temperature Applications — Sara Claramunt[1], •Muhammad Khurram[2], Walther Benzinger[1], Manfred Kraut[1], and Roland Dittmeyer[1] — [1]Institute for Micro Process Engineering, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany — [2]Institute for Physics, University of Greifswald, 17489 Greifswald, Germany

Hydrophobic porous metallic membranes can be integrated into a microreactor for in-situ separation of steam at high temperatures. This study investigates the fabrication and characterization of hydrophobic coatings on metallic substrates. Two different coating methods were explored: (1) plasma enhanced-chemical vapor deposition to form amorphous carbon silicon-doped a-C:H:Si:O thin films and (2) direct immersion in fluoroalkyl silane (FAS-13) solution using dip coating to form self-assembled monolayers. The results on wettability as well as SEM images and Energy Dispersive Spectroscopy/Wavelength Depressive Spectroscopy analyses indicate that the coated sintered stainless-steel membranes are adequate as hydrophobic surfaces, maintaining the porosity of the substrate and withstanding high temperatures. Especially the FAS-13 coating shows very good resistance to temperatures higher than 250°C. These findings are of special significance for the fabrication of porous metal membranes for the separation of steam in high-temperature applications.

CPP 37.6 Thu 12:15 H39

Superlatice deformation via uniaxial strain and its impact on photoluminescence in PbS quantum dot thin films — •Julian E. Heger[1], Wei Chen[1], Huaying Zhong[1], Tianxiao Xiao[1], Constantin Harder[1,2], Fabian A. C. Apfelbeck[1], Alexander Weinzierl[1], Regine Boldt[3], Lucas Schraa[3], Eric Euchler[3], Anna K. Sambale[3], Konrad Schneider[3], Matthias Schwartzkopf[2], Stephan V. Roth[2,4], and Peter Müller-Buschbaum[1,5] — [1]TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching — [2]DESY, 22607 Hamburg — [3]Leibniz-Institut für Polymerforschung IPFDD, 01069 Dresden — [4]Royal Institute of Technology KTH, 100 44 Stockholm — [5]MLZ, TU München, 85748 Garching

Colloidal lead sulfide quantum dots (PbS CQDs) show high potential for the application in flexible electronics, as they are solution processible with tunable optoelectronic properties. In thin films, PbS CQDs form a superlattice morphology that tailors these optoelectronic prop-

erties. For instance, electronic coupling between adjacent PbS CQDs is dependent on the inter-dot distance in the superlattice. In this work, we investigate the superlattice deformation during applied external strain. For this, PbS CQDs thin films are prepared on flexible PDMS substrates. The samples are investigated with in situ GISAXS and photoluminescence measurements at different levels of strain to correlate the deformation-induced morphological changes to the optoelectronic performance.

CPP 37.7 Thu 12:30 H39

The surface of electrolyte solutions is stratified — •Yair Litman, Kuo-Yang Chiang, Takakazu Seki, Yuki Nagata, and Mischa Bonn — MPI for Polymer Research, Mainz, Germany.

The electrical-double layer (EDL) model has been used during the last two decades to describe the behaviour of ions at the water/air interface, and also as a framework to analyze and interpret several types of surface-selective experimental measurements. In this work, we present a combination of surface-sensitive heterodyne-detected vibrational sum frequency generation (VSFG) and *ab initio* based molecular dynamics simulations to study the liquid/air interface of different aqueous electrolyte solutions. Our VSFG measurements clearly demonstrate that the EDL model is an incomplete microscopic picture to understand the interface of NaCl, NaBr and NaCl aqueous solutions and it is completely inappropriate for the NaOH and CsF cases. Based on our simulations, we propose that the surface of electrolytes solutions is stratified into two water layers, one depleted and the other enriched with ions, creating an effective liquid-liquid interface buried a few Å inside the solution.

CPP 37.8 Thu 12:45 H39

A purely ionic voltage effect soft triod — •Elalyaa Mohamed, Sabine Josten, and Frank Marlow — Kaiser-Wilhelm-Platz 1, 45470 Mülheim an der Ruhr

Iontronics is a concept of connecting ionic transport, storage and reactions with electronics. As ions are the language of nature and electrons are the language of man-made information processing, connecting both may lead to more understanding of nature as well as to new computational systems which might be called neuromorphic. In the last decade, many iontronic devices were invented and studied. However, developing of iontronics requires the invention of more flexible devices. In our lab we developed a purely ionic voltage effect soft triode (IVEST) based on interfacial ion adsorption and redox oxidizer depletion. The IVEST was built with no need of sophisticated or expensive materials. This device is an electrochemical micro-cell, which consists of a top electrode and two bottom electrodes. The basic idea of this device is to control the concentration and diffusion of ions by the voltage applied on the top electrode. In different electrical circuit configurations, it can show amplification or memory effects. The device had an electrical current amplification reaching 52 and memory effects in the electrical resistance lasting for up to 6 h. These values were achieved by tuning an electrode interface, the electrolyte and diffusion properties. They might be promising for neuromorphic applications.