

CPP 28: POSTERS Interfaces and Thin Films

Time: Wednesday 17:00–19:00

Location: P3

CPP 28.1 Wed 17:00 P3

High Frequency QCM Flow cell with Enhanced Accuracy for Liquid and Biochemical Sensing — ●BRIGITTE PAULA SAGMEISTER¹, SIEGFRIED BAUER¹, REINHARD SCHWÖDIAUER¹, and HERMANN GRUBER² — ¹Soft Matter Physics, Johannes Kepler University, Altenberger Str. 69, A-4040 Linz, Austria — ²Institute for Biophysics, Johannes Kepler University, Altenberger Str. 69, A-4040 Linz, Austria

The quartz crystal microbalance (QCM) has been proven to be a highly sensitive mass detector which found its way into biomedical sciences. The measuring technique is ideally suited for online detection of biological and chemical analytes and gets along without labelling them. Most biosensing systems based on thickness shear mode resonators work with resonance frequencies between 5 and 20 MHz and use commercially available flow cells. The utilisation of high frequency fundamental (HFF) quartz resonators, with resonance frequencies up to 200 MHz, could further improve the sensitivity of such systems. We present a fully biocompatible flow cell, designed for HFF quartz resonators. For the development of a biosensor we solved important questions like the functionalization of the small and fragile sensor surface, the sensitive and repeatable detection of dissolved analytes and the regeneration of the sensor. The system performance is further evaluated by a number of experiments including the step-wise growth of a protein multilayer system by an alternating immobilisation of streptavidin and biotinylated immunoglobulin G, as well as the detection of specific antibody-antigen reactions.

CPP 28.2 Wed 17:00 P3

Supported Lipid Bilayers on Spacious and pH Responsive Polymer Cushions with Varied Hydrophilicity — ●LARS RENNER¹, TILO POMPE¹, REGIS LEMAITRE², DAVID DRECHSEL², and CARSTEN WERNER¹ — ¹Leibniz Institute of Polymer Research Dresden, Max Bergmann Center of Biomaterials Dresden, Germany — ²Max-Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany

We report on the successful formation of supported multicomponent lipid bilayer membranes (sLBMs) from natural occurring lipids as well as synthetic lipids on a set of polymer cushions consisting of alternating maleic acid copolymers. Maleic acid copolymers provide a versatile platform to adjust the physico-chemical behaviour by the choice of the comonomer unit. The formation of sLBMs was triggered by a transient reduction of the electrostatic repulsion between the polymer cushions and the lipid vesicles by lowering the solutions pH to 4. Upon formation the stability of sLBMs was not affected by subsequent variations of the environmental pH to 7.2. The degree of hydrophilicity and swelling of the anionic polymer cushions was found to determine both the kinetics of the membrane formation and the mobility of the sLBM. An increase in cushion hydrophilicity correlated with a strong increase in the diffusion coefficient of the lipids. The observations strongly support the important role of the support's polarity for the fluidity of the sLBM. The investigated polymer cushions are considered to open new options for the in situ modulation of sLBM characteristics for the successful integration of functional transmembrane proteins.

CPP 28.3 Wed 17:00 P3

Controlled Wrinkling as a novel method for the fabrication of patterned surfaces — ●ALEXANDRA SCHWEIKART¹, CONGHUA LU², and ANDREAS FERY¹ — ¹University of Bayreuth, Physical Chemistry Department II, Bayreuth, Germany — ²MPI for Colloids and Interfaces, Department of Interfaces, Golm, Germany

Surfaces that are patterned on the sub-micron- or nanoscale are of great interest as building blocks for devices in areas as diverse as photonics (diffraction gratings), sensorics (pressure sensors), biotechnology (direction of cell growth), catalysis and stamps for microcontact printing. We present a new, lithography-free approach for creating such surfaces that is based on controlled wrinkling. Wrinkles develop if a soft substrate covered by a hard film is exposed to strain. Given the case that strain is controlled well and homogenous, wrinkle patterns are highly regular. They can be of sub-micron periodicity while the lateral dimensions of the substrate can be macroscopic. We use this approach to direct colloidal crystal assembly by using a template assisted self-assembly process. In the first part, we discuss recent experiments

on the mechanics of surface wrinkling on the micron/submicron scale. In the second part, we focus on applications of wrinkled surfaces for structuring and templating. Here, we show that the interaction between colloidal particles and wrinkled substrates as well as capillary forces direct colloids and nanoparticles into wrinkles with high regularity.

CPP 28.4 Wed 17:00 P3

High resolution, non-destructive, and quantitative material characterization on the nanoscale by HarmoniX-microscopy — ●HARTMUT STADLER — Veeco Instruments GmbH, Dynamostr. 19, D-68165 Mannheim (Germany)

The miniaturization of devices and functions down to the nanoscale regime require techniques for localized investigation of material properties. Particularly interesting are quantitative data on elastic, viscous or adhesive properties of thin layers or films (e.g. for their tribological or rheological behavior). Some of the already known and commercially available SPM modes (force-distance based or similar) reveal these properties to some extent, but they are limited in lateral/vertical resolution, sample compatibility, or speed of data acquisition.

Recently, HarmoniX-microscopy has been introduced as a new scanning probe mode, based on the well known and widely used standard tapping mode. HarmoniX allows nanoscale mapping of material properties such as elasticity, adhesion, and dissipation by analyzing the full spectrum of motion of special probes designed for high bandwidth measurement of tip forces. From the spectra, the force distance curves during the tapping cycles and the respective material properties of the sample can be extracted, and displayed as lateral maps in realtime. HarmoniX microscopy is hundreds of times faster than other quantitative material mapping techniques such as force volume, but retains the high resolution, non-destructive qualities of tapping mode imaging.

The fundamentals, instrumental aspects, and first applications of the new technique will be reviewed in this contribution.

CPP 28.5 Wed 17:00 P3

Growth of gold thin films on PVK-coated nanostructured titanium dioxide — STEPHAN V. ROTH², ●GERD HERZOG^{1,2}, RALF RÖHLSBERGER², SEBASTIEN COUET², KAI SCHLAGE², ANDRE ROTHKIRCH², ANDREAS TIMMANN², RALPH DÖHRMANN², NADJA REIMERS², HEINZ GRAAFSMA², MICHAEL LOHMANN², D. BISCHOFF², GUNAR KAUNE³, MATTHIAS RUDERER³, WEINAN WANG³, MOTTAKIN M. ABUL KASHEM³, EZZELDIN METWALLI³, WILFRIED WURTH¹, PETER MÜLLER-BUSCHBAUM³, and RAINER GEHRKE² — ¹Institut für Experimentalphysik der Universität Hamburg, Luruper Chaussee 149, D-22761 — ²HASYLAB at DESY, Notkestr. 85, D-22603 Hamburg, Germany — ³Physik-Department E13, TU München, James-Frank-Str. 1, D-85748 Garching, Germany

PVK-coated nanostructured TiO₂ films are candidates for photo-voltaic devices. To create an electrode, gold is sputter deposited onto the TiO₂/PVK film. Grazing incidence small angle x-ray scattering (GISAXS) is used for in situ investigation of gold cluster growth. Out of plane scans show two clearly separated peaks which leads to the conclusion that a bimodal distribution of particles is present, which we call large and small clusters. The temporal development of out of plane scans illustrates the kinetics of the radius of small clusters, while detector scans and off detector scans at the small clusters' Yoneda peak are used to discover the vertical growth of large and small clusters, respectively. Since the radius of the large clusters is found to be constant, they are thought to be voids in the polymer film caused by roughness in the TiO₂ layer which are filled with gold atoms.

CPP 28.6 Wed 17:00 P3

Glass transition in ultra thin polymeric films measured by differential AC chip calorimetry — ●HEIKO HUTH¹, DONGSHAN ZHOU², and CHRISTOPH SCHICK¹ — ¹University of Rostock, Institute of Physics Universitätsplatz 3, 18051 Rostock, Germany — ²Dept. of Polymer Science and Eng., Nanjing University, Nanjing, 210093, China

The film thickness dependency of glass transition in polymer films is still controversially discussed. For different experimental probes different dependencies are observed and a generally accepted link to molecular mobility is not yet established. Calorimetry has proven to provide

useful information about glass transition, because it establishes a direct link to energetic characterization. In several cases a direct comparison with results from other dynamic methods like dielectric spectroscopy is possible giving further insights. For thin films in the micro...nm range standard calorimetric methods are mostly not applicable. In the recent years there are new developments in the field of calorimetry which overcome these limitations. We set up a differential AC-chip calorimeter capable to measure the glass transition in nanometer thin films with pJ/K sensitivity. Changes in heat capacity can be measured for sample masses below one nanogram as needed for the study of the glass transition in nanometer thin polymeric films. No thickness dependency of the glass transition temperature was observed within the error limits - neither at constant frequency nor for the traces in the activation diagrams.

CPP 28.7 Wed 17:00 P3

Designing the interfacial properties of Langmuir monolayers from amphiphilic diblock copolymers — KATJA TRENKENSCHUH¹, FELIX SCHACHER², AXEL H. E. MÜLLER², and •LARISA TSARKOVA¹ — ¹Physikalische Chemie II, Universität Bayreuth, D 95440 Bayreuth, Deutschland — ²Macromolekulare Chemie II, Universität Bayreuth, D 95440 Bayreuth, Deutschland

We followed changes in the molecular arrangement of amphiphilic diblock copolymers at air-water interface which were associated with the variation of the molecular composition. We demonstrate that the main characteristics of the surface pressure – area per molecule ($\pi - A$) isotherms strongly depend on the mechanical properties of the hydrophobic block (polystyrene (PS) or polybutadiene (PB)), and on the volume fraction of the hydrophilic block poly(N, N-dimethylaminoethyl-methacrylate) (PDMAEMA). In the case of a majority PB block, the interfacial assembling shows clear dependence on the chain relaxation, while a PS majority block leads to a significantly larger mechanical stability of the monolayers. The contribution of the PDMAEMA block is noticeable at low compressions and at low pH values due to the protonation of the chains. The nanostructure of Langmuir-Blodgett films was investigated with scanning force microscopy (SFM). We captured the details of the phase transition from a network of PS-core worm-like micelles to densely packed PS-core spherical domains through increasing the monolayer compression. Our results further establish the generality of the molecular-structure guided assembling phenomena.

CPP 28.8 Wed 17:00 P3

Voltage-dependent uptake of L-glutamate by polypyrrole films analysed in situ with EQCM — •KATHRIN FUCHS, ELIZABETH VON HAUFF, and JÜRGEN PARISI — Energy- and Semiconductor Research Laboratory, Department of Physics, University of Oldenburg, Carl-von-Ossietzky-Strasse 9-11, D-26111 Oldenburg

L-glutamate is an important neurotransmitter in the human central nervous system. Molecular selective surfaces which can control the concentration of biomolecules such as glutamate could find a broad range of application in the fields of biology and medicine.

For this purpose, electropolymerized polypyrrole (PPy) films doped with glutamate were characterized as glutamate-selective surfaces for the uptake and release of L-glutamate via a variable potential. The films were deposited potentiostatically on gold electrodes and 5 MHz Au-coated AT-cut quartz crystals, respectively, in an aqueous solution containing 0.4 M pyrrole and 0.5 M sodium L-glutamate. After deposition PPy films were overoxidized potentiodynamically in aqueous 0,1 M NaOH in order to create a complementary cavity for the recognition of L-glutamate molecules [1]. Subsequently, the efficiency of the PPy film for the uptake and release of L-, D-Glutamate and chlorine depending on the applied voltage was analysed in situ with an electrochemical quartz crystal microbalance (EQCM). Furthermore the morphology of the films were investigated with a scanning electron microscope.

[1] B. Deore, Z. Chen, and T. Nagaoka, *Anal. Sci.*, 15, 827, 1999

CPP 28.9 Wed 17:00 P3

Inkjet Printing of Polymer Microspheres — ENRICO SOWADE¹, JENS HAMMERSCHMIDT¹, DAVID POLSTER², REBECCA WAGNER³, THOMAS BAUMGÄRTEL⁴, •THOMAS BLAUDECK¹, HARALD GRAAF², FRANK CICHOS³, CHRISTIAN VON BORCZYKOWSKI², and REINHARD R. BAUMANN¹ — ¹Print and Media Technology, 09107 Chemnitz, Germany. — ²Optical Spectroscopy and Molecular Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany. — ³Molecular Nanophotonics, University of Leipzig, 04103 Leipzig. — ⁴Graduate

School of Engineering Science, Osaka University, Osaka 560-8531, Japan.

During this decade, drop-on-demand piezo inkjet printing has gained considerable interest as it allows for a personalized and patterned deposition of thin functional films at ambient conditions. We report about libraries of inkjetted polymer microspheres with varying drop-to-drop space, head-to-substrate distance, solvent composition and substrate properties. The layers are characterized by AFM and optical microscopy aiming to understand the self-assembly phenomena of the spheres on the substrate.

CPP 28.10 Wed 17:00 P3

Solvent content in thin spin-coated polymer nanocomposite films — •JAN PERLICH¹, EZZELDIN METWALLI¹, MINE MEMESA², ROBERT GEORGH³, JOCHEN S. GUTMANN^{2,4}, and PETER MÜLLER-BUSCHBAUM¹ — ¹TU München, Physik-Department LS E13, James-Franck-Str. 1, 85748 Garching (Germany) — ²Max-Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz (Germany) — ³FRM-II, TU München, Lichtenbergstr. 1, 85747 Garching (Germany) — ⁴Inst. Phys. Chem., Johannes Gutenberg Universität, Jakob-Welder-Weg 10, 55099 Mainz (Germany)

The amphiphilic diblock copolymer P(S-b-EO) is used as template to synthesize nanocomposite films composed of ordered titania nanoparticles. In this approach a so-called "good-poor solvent pair" induced phase separation process is coupled with sol-gel chemistry. As result of the complex force balance, different nanocomposite morphologies can be obtained by adjusting the relative weight fractions between the sol-gel components, i.e. 1,4-dioxane, HCl and titania precursor. Directly after spin-coating the thin polymer nanocomposite films are investigated with neutron reflectivity (NR). The use of deuterated solvents generates contrast for the NR experiment. In NR a narrow range around the critical edge of total external reflection is probed with high resolution. Due to the high sensitivity of the position of the critical edge on the ratio of protonated P(S-b-EO) and deuterated solvent (1,4-dioxane), the exact position of the critical edge enables to determine the content of remaining solvent. The focus is on the systematic variation of the sol-gel components addressing different morphologies.

CPP 28.11 Wed 17:00 P3

Mechanical stability and permeability of porous polyaniline films fabricated by using polymer matrixes as templates — ALEXANDER SOKOLYUK^{1,2}, VLADIMIR G. SERGEYEV¹, and •LARISA TSARKOVA² — ¹Polymer Division, Department of Chemistry, Moscow State University, 119992, Moscow Russia — ²Physikalische Chemie II, Makromolekulare Chemie II,

Nanostructured polyaniline (PANI) composites have high potential in chemo- and biosensor technology due to their high sensitivity and fast response. We report the preparation of porous 3D interconnected structure of PANI by using as templates polymer films with varied mechanical and physico-chemical properties. Micro-structured layers of PANI have been characterized with SEM, SFM techniques and by contact angle measurements. The permeability of the nano-composites has been investigated by exposing the films to the vapor of organic solvent or water, and by monitoring the response using in-situ spectroscopic ellipsometry. We demonstrate that incorporation of PANI particles into the polystyrene (PS) films dramatically affects the mechanical stability of the resulting composite, independent on the thickness of the underlying PS template. Both the mechanical stability and permeability of PANI-based composite films are improved by using templates from elastomeric block copolymers or from amphiphilic block copolymers.

CPP 28.12 Wed 17:00 P3

Orientation and spatial distribution of dyes binding to SiO₂ surfaces — •SCHUBERT SEBASTIAN, TÄUBER DANIELA, KOWERKO DANNY, SCHUSTER JÖRG, and VON BORCZYKOWSKI CHRISTIAN — nanoMA TU-Chemnitz, Institut für Physik, 09107 Chemnitz.

Silica surfaces are widely used e.g. in the fabrication of organic electronic devices. Yet many details of the interactions between silica surfaces and organic molecules which are crucial for their electrical properties and thus for device performance are not fully understood.

Here we use ensemble fluorescence and single molecule methods to explore the spatial distribution, molecular orientation and spectral dynamics of differently functionalized dyes on silica surfaces [1]. This allows us to draw conclusions on preferential geometrical orientations and physio-chemical binding affinities depending on the chemical structure of participating molecules and silica surfaces.

[1] D. Kowerko, J. Schuster, Ch. von Borczyskowski: Molecular Physics submitted

CPP 28.13 Wed 17:00 P3

Application of in-situ ellipsometry for the investigation of stimulis-responsive polymer brushes and adsorption processes thereon — ●EVA BITTRICH¹, DENNIS AULICH², KLAUS - JOCHEN EICHHORN¹, KARSTEN HINRICHS², PETRA UHLMANN¹, and MANFRED STAMM¹ — ¹Leibniz Institute of Polymer Research Dresden, Hohe Str. 6, 01069 Dresden, Germany — ²ISAS - Institute for Analytical Sciences, Department Berlin, Albert-Einstein-Str. 9, 12489 Berlin, Germany

Thin polymer brushes, with the polymer chains grafted chemically by one end to the surface, have thoroughly proven their ability to modify physico-chemical interface properties as well as the adsorption behaviour of proteins at artificial surfaces. With the help of in-situ spectroscopic ellipsometry these thin polymer films can be investigated according to their swelling behaviour and adsorption processes at the polymer-solution interface.

We report on swelling measurements of homopolymer and mixed polymer brushes consisting of pH- and temperature sensitive polymer chains. Furthermore we investigated the adsorption of human serum albumin, a protein of the blood plasma, onto charged polymer brushes. Here we monitored the influence of changes in the environmental conditions and the composition of the polymer brush on the adsorbed amount as well as the optical properties of the protein layer.

CPP 28.14 Wed 17:00 P3

Collective behavior during dewetting — ●CRISTINA-MARIA POP¹, ANA MARIA FLORESCU², YVES BRÉCHET³, and ZOLTÁN NÉDA⁴ — ¹Arnold Sommerfeld Center and CeNS, Ludwig-Maximilians-Universität München, Germany — ²LSP, Université Joseph Fourier, St Martin d'Hères Cedex, France — ³SiMAP-ENSEEG, Institut National Polytechnique de Grenoble, St Martin d'Hères Cedex, France — ⁴Babeş-Bolyai University, Cluj-Napoca, Romania

When a liquid film on a substrate is unstable, dry spots appear and the liquid breaks into droplets: this phenomenon is called dewetting. It can be observed every day on a windshield or in a cooking pan, and the stability of liquid films on solid substrates is crucial for numerous technological applications. In biology, dewetting governs the dynamics of adhesion on wet substrates in the case of mushroom spores or living cells. Dewetting can take place through amplification of capillary waves in thin films, or by spontaneous nucleation and growth in thicker films.

We studied the mechanism of dewetting by introducing a two-dimensional model in which the dynamics of the dewetting hole is given by capillarity (the line tension which tends to shrink the hole, and the difference between the surface energy of the substrate when dry and wet). Dissipation makes the motion overdamped. With the aid of this model we performed numerical simulations which enabled us to find the critical parameters for the growth of a dewetting hole, and to study the collective dynamics of many holes in a dewetting process with spontaneous nucleation. Thus we obtained a size distribution of the liquid droplets on the substrate after dewetting has taken place.

CPP 28.15 Wed 17:00 P3

Effect of geometrical confinement and surface charge on the structuring in colloidal silica suspensions — ●YAN ZENG¹, SABINE KLAPP², and REGINE V. KLITZING¹ — ¹Stranski-Laboratorium für Physikalische & Theoretische Chemie, Institut für Chemie, TU Berlin — ²Institut für Theoretische Physik, Freie Universität Berlin

This work focuses on the effect of geometric confinement on the structuring of colloidal suspensions in thin film geometry. Colloidal silica suspensions with different particle concentration and ionic strength allow a deeper insight into the ion distribution around the particles. Results from colloidal probe atomic force microscopy (CP-AFM) force-distance measurements in films are compared with results from small-angle X-ray scattering (SAXS) in bulk. It is found that the characteristic lengths obtained from force oscillation measured by AFM, correlate well with the intermediate particle distance from the structure peak measured by SAXS, scale with particle concentration with an exponent of $-1/3$. In order to study the effect of the surface elasticity the bare silicon surfaces are modified by polymer coatings. The effect on the structuring of particles is measured by AFM and compared with our preliminary results from Thin Film Pressure Balance (TFPB).

CPP 28.16 Wed 17:00 P3

Optical microscopy of colloidal polymeric thin films - ordering on large length scales — ●JANNIS LEHMANN^{1,2}, GERD HERZOG^{1,3}, ADELIN BUFFET¹, PETER MÜLLER-BUSCHBAUM⁴, RAINER GEHRKE¹, and STEPHAN V. ROTH¹ — ¹DESY, Notkestr. 85, D-22607 Hamburg, Germany — ²Univ. Hamburg, Dep. f. Physik, Jungiusstr. 9, D-20355 Hamburg, Germany — ³ExpPh, Univ. Hamburg, Luruper Chaussee 149, D-22761 Hamburg, Germany — ⁴Physik-Department E13, TU München, D-85748 Garching, Germany

Colloidal films are widely applied in many areas of research and technology, e.g. magnetic data storage or due to their optical properties [1,2,3]. We focused on the long-range order of spin-coated (on top of basic cleaned Si-wafers) colloidal polystyrene spheres (diameter 100nm) by using optical microscopy. We investigated the influence of colloidal concentration, spin-coating parameters and annealing on the structure of the colloidal film. Especially, annealing is performed far below as well as near the glass transition temperature of polystyrene of about 100°C to investigate the influence of mobility on the structure of the film during. We clearly see a regular periodic constitution of colloid-islands, which are homogeneously ordered on the surface. This long-range order extends from some ten micrometers to over several millimeters.

[1] Abul Kashem et al., *Macromolecules* 40, 5075-5083 (2007)

[2] Siffalovic et al., *Phys. Rev. B* 76, 195432 (2007)

[3] Roth et al., *Appl. Phys. Lett.* 91, 091915 (2007)

CPP 28.17 Wed 17:00 P3

AFM based approach to measure adhesion energies of micron sized particles predicated on JKR apparatus — ●JOHANN ERATH and ANDREAS FERY — University Bayreuth, Universitätsstr. 30, 95440 Bayreuth, Germany

Determination of adhesion energies is of interest for both fundamental science and applications. The aim of this contribution is to introduce a novel, AFM based approach for the case of soft surfaces.

Our approach builds up on the so called JKR (Johnson, Kendall and Roberts) apparatus. This device is used for macroscopic measurements and is based on the fact that the contact area of elastomeric lenses is only dependent on adhesion energy as well as elastic properties and load force. Thus, adhesion energy can be determined from measurement of contact area as a function of load.

In our case, the same principle is used for micron sized particles made from PDMS. We attach the particles to an AFM setup (soft colloidal probe AFM), whereby one can control the load and simultaneously measure the particle-surface contact area using microinterferometry.

We discuss the potential and advantages of this microscopic approach compared to classic JKR apparatus.

CPP 28.18 Wed 17:00 P3

Surface energy patterns generated by single pulse laser interference lithography — ●TOBIAS GELDHAUSER¹, STEFAN WALHEIM², THOMAS SCHIMMEL^{2,3}, PAUL LEIDERER¹, and JOHANNES BONEBERG¹ — ¹Universität Konstanz, 78457 Konstanz, Deutschland — ²Institute of Nanotechnology (INT), Forschungszentrum Karlsruhe, 76021 Karlsruhe, Deutschland — ³Institute of Applied Physics, Center for Functional Nanostructures (CFN), Universität Karlsruhe, 76128 Karlsruhe, Deutschland

Single pulse laser interference lithography is used to structure self-assembled monolayers of thiol on gold by thermal desorption in a rapid and large area (mm²) process. The desired structure can be varied by different angles of incidence and numbers of interfering laser beams. The structuring process is investigated by attenuated total reflection and AFM measurements. For comparison with the experiment 1D and 2D simulations of temporal heat distributions are presented. As a verification of this patterning process and example structures down to 200nm in width generated by demixing of polymers, sol-gel and guided assembly of colloids are shown.

CPP 28.19 Wed 17:00 P3

The bending rigidity of the liquid/vapour interface of water — ●FELIX SEDLMEIER, DOMINIK HORINEK, and ROLAND R. NETZ — Physik Department, Technische Universität München, 85748 Garching, Deutschland

Whenever two liquid phases are in contact, thermally excited fluctuations of the interface position, i.e. capillary waves, occur. At large length scales, they are well described by a constant interfacial tension in the framework of capillary wave theory. On smaller scales, however, deviations from capillary wave theory arise, which lead to an effective

surface tension that is a function of the wave vector of the excitation modes. The coefficient of the quadratic order term of the effective surface tension can be identified with Helfrich's bending rigidity, the sign and magnitude of which has been a long standing issue in theoretical as well as experimental research. Also, simulation studies of simple liquids have not given a conclusive answer yet. One of the main problems in the analysis of capillary waves at liquid interfaces is that at small scales interfacial fluctuations are entangled with bulk-like density fluctuations. For an unambiguous determination of the bending rigidity, these contributions have to be separated. We present results from large scale molecular dynamics simulations that elucidate the effect of this entanglement and give quantitative results for the bending rigidity of the liquid/vapour interface of water.

CPP 28.20 Wed 17:00 P3

Internal structure of PNIPAM microgel particles — ●MARTIN MEDEBACH¹, ANNA BURMISTROVA¹, MATTHIAS KARG¹, YVONNE HERTLE², WEINAN WANG³, PETER MÜLLER-BUSCHBAUM³, and REGINE V. KLITZING¹ — ¹Technische Universität Berlin — ²Universität Bayreuth — ³Technische Universität München

Thermosensitive microgel particles are of great interest in basic research and also for technical applications. For instance Poly-(N-Isopropylacrylamide), PNIPAM, undergoes a temperature induced phase transition at approx. 32 °C. This transition leads to shrinking by a factor of 10, while the shrinking effect at the solid/liquid interface is only about factor 2 perpendicular to the surface. These findings raise the question how the interactions with the solid surface affect the internal structure of the microgel particles. We report about experiments (GISANS, SANS, AFM and ellipsometry) with charged PNIPAM microgel particles (diameter in bulk between 100 to 1000 nm, depending on the degree of swelling) adsorbed on oppositely charged Silicon wafers. The PNIPAM particles are copolymerized with 5% acrylic acid and they are adsorbed on top of a Silicon wafer that is coated with Polyethyleneimine (PEI). The particles are close packed. From ellipsometry and AFM measurement the swelling is observed normally and laterally (AFM) to the surface. SANS experiments show the correlation length in the bulk system while GISANS measure the correlation length of the absorbed particles in lateral direction. Taken all experiments together we can describe the change of the internal structure during the swelling.

CPP 28.21 Wed 17:00 P3

AFM Studies of photoswitchable nanocomposite films — ●M. MÜLLER¹, Y. GONZALEZ-GARCIA¹, C. PAKULA², V. ZAPOROJTCHEIKO², F. FAUPEL², and O. MAGNUSSEN¹ — ¹Institut für Experimentelle und Angewandte Physik, Leibnizstrasse 19, Universität Kiel — ²Lehrstuhl für Materialverbunde, Kaiserstrasse 2, Universität Kiel

Photoswitchable conductive nanocomposites of metal nanoparticles and polymers containing photoisomerizable groups may have interesting applications as sensors and photoswitchable filters. We have investigated composite films of Au clusters and PMMA with embedded azobenzene, which can be optical switched between the trans and the cis isomer, resulting in photo-induced changes in the film conductivity. The film morphology and local conductivity have been characterized by a conductive sensing AFM (CS-AFM) with integrated UV/visible optics that allows in situ studies of illumination effects. According to these studies the change in configuration is accompanied by changes in the nanoscale film morphology, such as changes in free volume and a decrease of the surface roughness.

CPP 28.22 Wed 17:00 P3

Block Copolymer Templating using Periodic Chemical Nano-Patterns Induced with the Tip of an Atomic Force Microscope — ●TOBIAS HEILER¹, REGINA WEINGAERTNER², VASSILIOS KAPAKLIS³, ROLAND GROEGER², STEFAN WALHEIM¹ and THOMAS SCHIMMEL^{1,2} — ¹Institute of Nanotechnology (INT), Forschungszentrum Karlsruhe, Germany — ²Institute of Applied Physics and DFG-Center for Functional Nanostructures (CFN), Universität Karlsruhe, Germany — ³present address: Engineering Science Department, University of Patras, 26504 Patras, Greece

The nanoscale phase morphology of an amphiphilic block copolymer film was controlled by a chemical periodic surface energy pattern made by molecular exchange with the tip of an Atomic Force Microscope (AFM). The two polymer components of the copolymer, as well as the two surface molecules of the chemically patterned substrate possess a high contrast in polarity, so that a defect-

tolerant pattern replication with a line width of 40 nm in the polymer film is observed after a short (vapor-)annealing process. We used polyethylenoxide-polyisoprene-polyethylenoxide block copolymers and methyl- vs. carboxyl-terminated alkane thiols as self-assembled monolayers.

CPP 28.23 Wed 17:00 P3

Transient waviness of polymer films during spin-coating — ●JOERG PFEIFER¹, STEFAN WALHEIM², and THOMAS SCHIMMEL^{1,2} — ¹Institute of Applied Physics and DFG-Center for Functional Nanostructures (CFN), Universität Karlsruhe, Germany — ²Institute of Nanotechnology (INT), Forschungszentrum Karlsruhe, Germany

The development of roughness (waviness) during spin-coating of polymer films is a well known phenomenon of high technological relevance. We have investigated the transient formation of such waves in film thickness using time-resolved light reflectance measurements during the spin-coating process. Our model system (Polystyrene (PS) in Cyclohexane) develops this instability during the last 200 milliseconds of the drying process. By controlling the process atmosphere containing a defined load of solvent vapour, the formation and recovery of film waviness (wavelength: 20-50 micron) was observed. In this way, we were able to pre-adjust the amplitude of the developing waves from zero to 100 nm in films with an average thickness of 200 nm. The results of our quantitative investigations give rise to a model of solvent-polymer phase separation during spin-coating as the driving mechanism for this widely observed instability.

CPP 28.24 Wed 17:00 P3

Polymer phase separation on surface energy patterns generated by single pulse laser interference — ●ALEXANDER FOERSTER¹, TOBIAS GELDHAUSER², JOHANNES BONEBERG², PAUL LEIDERER², STEFAN WALHEIM¹, and THOMAS SCHIMMEL^{1,3} — ¹Institute of Nanotechnology (INT), Forschungszentrum Karlsruhe, Germany — ²Department of Physics, Universität Konstanz, Germany — ³Institute of Applied Physics and DFG-Center for Functional Nanostructures (CFN), Universität Karlsruhe, Germany

Single pulse laser interference lithography is used to structure self-assembled monolayers of thiols on gold. The molecular desorption process is investigated by attenuated total reflection measurements. The resulting surface energy patterns are investigated by AFM and are used to control the phase morphology of a polymer blend - subsequently spin-cast on these structured surfaces. The laser lithography was realized with different wavelengths (266, 532, and 1064 nm) which shows that the structuring is a thermal process. As a first demonstration of this process, structures down to 800 nm period and 300 nm width are fabricated. Ref.: Langmuir 24 (22), 13155-13160 (2008)

CPP 28.25 Wed 17:00 P3

A transient triple layer leads to a purely lateral morphology in a spin-cast polymer blend film — ●CHENG HUANG¹, AARON WEIS², FENGZHEN ZHANG³, OTHMAR MARTI³, STEFAN WALHEIM¹, and THOMAS SCHIMMEL^{1,2} — ¹Institute of Nanotechnology (INT), Forschungszentrum Karlsruhe, Germany — ²Institute of Applied Physics and DFG-Center for Functional Nanostructures (CFN), Universität Karlsruhe, Germany — ³Institute for Experimental Physics, Universität Ulm, Germany

We study the phase separation process of PS/PMMA during spin-coating from a Methyl-Ethyl-Ketone (MEK) solution. Using this solvent this polymer blend forms a purely lateral structure on a hydrophilic substrate with PS cylinders in PMMA matrix. Our results of time-resolved reflectometry point in the direction of a transient triple layer formation during the spin-coating process which then transforms via an instability into the final lateral morphology. The process parameters can be tuned so that a purely horizontally layered situation can be observed in the dried state. Humidity, spin rate and the concentration of the polymer blend solution are the most important parameters which define the final structure. The PS or PMMA phase was later selectively dissolved and the film was subsequently used as a lithographic mask.

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Thickness dependence of diffusion in thin liquid crystalline films — ●BENJAMIN SCHULZ, JÖRG SCHUSTER, and CHRISTIAN VON BORCZYKOWSKI — TU Chemnitz, Institut für Physik, 09107 Chemnitz

Liquid crystals are of high technical interest especially for the use in

liquid crystal displays. As all applications are based on the orientational behaviour of the molecules, especially on surfaces, it is important to examine the molecular alignment and mobility in proximity to solid interfaces.

We are using single molecule microscopy to track the trajectories of dyes dissolved in the liquid crystal. This allows us to directly access to the molecular movement in the specimen. We are using specially tailored perylene dye molecules that align in the liquid crystal matrix and which are thus a good representation of the real behaviour of the liquid crystal molecules. The comparison with the diffusive behaviour of randomly aligning dye molecules gives us the chance to investigate the local structure on the surface. We find a drastic slowdown of diffusion as the film thickness decreases for both types of tracers, however, with a different thickness dependence. Film thickness is hereby varied from extremely thin quasi 2D films consisting of a single smectic double layer, up to quasi bulk material, where a crossover to 3D structured films (FCDs) is observed.

With our method we try to establish a model of the structure of extremely thin smectic liquid crystals, a question which is not yet re-

solved in literature, by relating the diffusive behaviour of the liquid crystals to the three dimensional patterning.

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Thermotropic liquid crystal foams — ●TORSTEN TRITTEL, THOMAS JOHN, and RALF STANNARIUS — Otto-von-Guericke-Universität Magdeburg

Foams made from surfactant solutions are well investigated and understood, but there is no information about properties of foams made from pure thermotropic materials. This new type of foams has advantages compared with ordinary soap foams. For example, higher stability and slower drainage. In our experiments, we investigate two-dimensional foams, made from liquid crystals in the smectic A phase, with the aid of digital image analysis. We focus on the temporal evolution (ageing) of these foams, especially in the long time regime, where scaling behaviour occurs. The evolution of the mean bubble radius (R) and distribution functions, e.g. bubble size distribution, are determined and compared with soap foams.