

CPP 14: Membranes

Time: Tuesday 15:00–16:30

Location: C 230

CPP 14.1 Tue 15:00 C 230

Free Volume and Permeability in Boltorn-modified Gas Separation Membranes — •KLAUS RÄTZKE¹, JAN KRUSE¹, FRANZ FAUPEL¹, DANA STERESCU², DIMITRIOS STAMATIALLIS², MATTHIAS WESSLING², and EDUARDO MENDES³ — ¹3. Technische Fakultät Universität Kiel, Germany — ²1. University of Twente, The Netherlands — ³2. Delft University of Technology, The Netherlands

This paper describes the permeation properties of poly (2, 6-dimethyl-1,4-phenylene oxide) (PPO) dense polymer films containing aliphatic hyperbranched polyesters, Boltorn (H40) which are dispersed at various concentrations. Focus is on the correlation between permeation and free volume, which was determined by positron annihilation lifetime spectroscopy, using a well established correlation between orthopositronium lifetime and average free volume size. The gas permeability of PPO with 1.0 wt % of Boltorn is 2-3 times higher than the pure polymer, while at higher concentration (9.1 wt %) of Boltorn the permeability becomes almost 50 % of the pure polymer. The gas pair selectivity, however, stays constant. The increase in permeability at low concentration of Boltorn is due to the increase of the free volume, probably due to hydrogen bonds between Boltorn and the oxygen of PPO backbone. The decreased permeability of PPO containing higher concentration of Boltorn (9.1 wt %) is due to two reasons: decrease in free volume as determined by PALS as well as phase separation. D. Sterescu, D. Stamatialis, E. Mendes, J. Kruse, K. Rätzke, F. Faupel, M. Wessling *Macromolecules*, 40 (2007) 5400.

CPP 14.2 Tue 15:15 C 230

Novel carbon nanomembranes as support for ultrahigh resolution structural analysis of nanoparticles — •CHRISTOPH NOTTBOHM¹, ANDRÉ BEYER¹, ALLA SOLOGUBENKO², INGA ENNEN¹, ANDREAS HÜTTEN¹, HARALD RÖSNER³, WOLFGANG ECK⁴, JOACHIM MAYER², and ARMIN GÖLZHÄUSER¹ — ¹Fakultät für Physik, Universität Bielefeld — ²RWTH Aachen — ³Forschungszentrum Karlsruhe — ⁴Universität Heidelberg

The resolution in transmission electron microscopy (TEM) has reached values as low as 0.08 nm. However, these values are not accessible for very small objects in the size range of a few nanometers or lower as they have to be placed on some support, which contributes to the overall electron scattering signal, thereby blurring the contrast. Here, we report on the use of nanomembranes made from cross-linked aromatic self-assembled monolayers as TEM sample supports. When transferred onto a copper grid, a single 1.6 nm thick nanomembrane can cover the entire grid and is free-standing within the micron-sized openings. Despite its thinness, the membrane is stable under the impact of the electron beam. Micrographs taken from nanoclusters onto these nanomembranes show highly increased contrast in comparison to images taken from amorphous carbon supports. In scanning transmission electron microscopy with nanomembrane support, a size analysis of sub-nanometer Au clusters was performed and single Au atoms were resolved.

CPP 14.3 Tue 15:30 C 230

Mechanical properties of freestanding nanomembranes from self-assembled monolayers — •XIANGHUI ZHANG, NILS MELLECH, CHRISTOPH NOTTBOHM, ANDRÉ BEYER, and ARMIN GÖLZHÄUSER — Fakultät für Physik, Universität Bielefeld, Postfach 100131, 33501 Bielefeld, Germany

Ultrathin membranes are promising materials in science and nanotechnology. Here we report the characterization of nanomembranes with a thickness of approximately 1.5 nm, which have a remarkable high tensile strength and excellent elasticity. The nanomembranes are aromatic self-assembled monolayers (SAMs) that are laterally crosslinked by electron irradiation. The SAMs are prepared on silicon-nitride windows, supported by a silicon frame. Afterwards the silicon nitride is dissolved, providing freestanding nanomembranes that cover openings in silicon substrate with sizes from 10 μm to 50 μm . Bulge testing is used to determine Young's modulus and residual stress of the freestanding nanomembranes. Rupture testing is performed to measure tensile strength. The nanomembranes display outstanding performance in tensile strength of up to 700 MPa, which is 4~7 times higher than the highest currently known value for nanomembranes. The electron dose dependences of tensile strength, the Young's modulus and

the residual stress of the nanomembranes have been systematically studied. This allows to tailor its mechanical properties for the fabrication of nanoelectromechanical (NEMS) devices.

CPP 14.4 Tue 15:45 C 230

Polyelectrolyte-surfactant interactions in foam films — •NORA KRISTEN¹, VASILE SIMULESCU^{1,2}, and REGINE V. KLITZING¹ — ¹Stranski-Laboratorium, Institut für Chemie, Technische Universität Berlin, Str. d. 17.Juni 124, 10623 Berlin — ²West University Timisoara, 300223 Timisoara, Rumania

Interactions between polyelectrolytes and surfactants in foams are of interest for many technical applications, e.g. in cleaning processes. Foam consists of many single free-standing films; to investigate these foam films a so called Thin Film Pressure Balance (TFPB) is used. With this apparatus disjoining pressure isotherms are measured (disjoining pressure vs. film thickness).

Depending on the charge combination of the surfactant and the polyelectrolyte, two different types of films can be formed: either a Common black Film (CBF, mainly stabilized by electrostatic forces) or a Newton Black Film (NBF, mainly stabilized by steric forces).

The addition of polyelectrolytes affects the interactions within the foam due to complexation between the surfactant and the polyelectrolyte at the surfaces. With a cationic surfactant like C(n)TAB a film with positive charged surfaces is formed. After addition of negative polyelectrolyte, the charge at the surface is reversed. In both cases, a CBF is formed due to the electrostatic repulsion of the two interfaces. But what happens at isoelectric point of the surface charge: Is a NBF formed or does the film break? The addition of very low polyelectrolyte concentrations leads to a low net surface charge. Therefore the stability of films with a low polyelectrolyte concentration is investigated.

CPP 14.5 Tue 16:00 C 230

Dynamics of Phospholipids in the Stabilizer Layer of Dispersed Lipid Nanoparticles Investigated by Quasielastic Neutron Spectroscopy — •TOBIAS UNRUH, SEBASTIAN BUSCH, and CHRISTOPH SMUDA — Technische Universität München, Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM II) and Physik Department E13, Garching, Germany

Dispersions of colloidal lipid particles such as triglyceride nanoparticles are used as delivery systems for intravenous administration of drugs. The stabilizing properties of the surfactant layer in the interface between the nanoparticles and the aqueous dispersion medium are determined i.a. by the dynamics of the stabilizer molecules, which holds in particular if the dispersed particles undergo rapid shape or size changes as e.g. during their production in a homogenizer or their crystallization after preparation [1].

Investigations on the dynamics of phospholipid molecules in dispersions of alkanes and triglycerides performed by quasielastic neutron spectroscopy (QENS) will be presented. The measurements were carried out at the high resolution time-of-flight spectrometer TOFTOF of the FRM II in Garching. Due to the high neutron flux of the instrument the investigation of samples with only 20 mg of phospholipid in the beam was possible. The dynamics of the phospholipids is compared to their dynamics in the bilayers of small unilamellar vesicles (SUVs) and the effect of the addition of a co-surfactant on the phospholipid dynamics will be discussed.

[1] K. Westesen, B. Siekmann, *Int. J. Pharm.*, 151 (1997) 35

CPP 14.6 Tue 16:15 C 230

Nanoporous Templates from Supramolecular Assembly of Block Copolymers — •BHANU NANDAN, MARCUS BÖHME, RADIM KRENEK, and MANFRED STAMM — Leibniz Institute of Polymer Research Dresden, Hohe Strasse 6, 01069 Dresden

Highly ordered arrays of nanostructures derived from block copolymer self-assembly have attracted lot of attention for nanotechnological applications, such as in nanostructured networks and membranes, nanoparticles templates and nanoreactors, photonic crystals, and high density information storage media. In the present work, we investigated nanotemplates based on supramolecular assembly (SMA) of polystyrene-*block*-poly(4-vinylpyridine) (PS-*b*-P4VP) and a low molar mass additive 2-(4'-hydroxyphenylazo)benzoic acid (HABA). The strong repulsion between PS and P4VP in this system allowed fab-

rication of templates with characteristic length-scale which was not accessible in the past with other block copolymers. Moreover, the morphology of these nanotemplates could be tailored by (1) choosing block copolymer of appropriate block length ratio, (2) varying concentration of HABA, or (3) by blending the SMA with respective homopolymers.

Long range order was improved by solvent annealing under controlled conditions and using substrates of low roughness. It is further shown that the SMA fabricated in this work can be used to template various functional inorganic nanostructures by electrodeposition, physical vapour deposition or by soaking in nanoparticle solutions.