CPP 18 Polymer Materials II

Time: Wednesday 15:45–17:15 Room: ZEU 114

CPP 18.1 Wed 15:45 ZEU 114

Thiol molecules can build up far more than a monolayer: Substrate-Consuming Metal-Organic Layers (SCMOLs) — •Stefan Walheim [1], Matthias Barczewski[1,2], Birgit Riedel[1], Jochen Geerk[3], Alfred Blaszczyk[1], Marcel Mayor[1,4], and Thomas Schimmel[1,2] — [1]Institute for Nanotechnology, Forschungszentrum Karlsruhe, 76021 Karlsruhe (Germany) — [2]Institute of Applied Physics, University of Karlsruhe, 76131 Karlsruhe (Germany) — [3]Institute for Solid-State Physics, Forschungszentrum Karlsruhe, 76021 Karlsruhe (Germany) — [4]Chemistry Department, University of Basel, 4056 Basel (Swizerland)

A novel procedure for the self-assembly of metal-organic layers is described. These layers grow from metal substrates. The organic (thiol)-molecules gradually combine with the metal atoms of the substrate to build up an optically transparent metal-organic solid. The metal atoms are essentially consumed during the growth process. For this reason we call these layers - which can reach thicknesses up to 1 micron - Substrate-Consuming Metal-Organic Layers (SCMOLs). Rutherford Back-Scattering (RBS), Small Angle X-Ray Scattering (SAXS) and Atomic-Force Microscopy (AFM) were applied to gather information about the growth behaviour and the morphology of this nano-structured material. This opens perspectives towards the development of a new type of self-assembled thin solid films with possible applications, e. g. for novel procedures of constructive lithography.

[1] S. Walheim, M. Barczewski, A. Blaszczyk, M. Mayor, Th. Schimmel, Patent application: DE 102005025693.7 (2005)

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Optical or electrical poling of azo-dye layers — •Ansgar Draude[1], Sven Verpoort[1], Rafael Meinhardt[1], Hilmar Franke[1], and Roger A. Lessard[2] — [1]Fachbereich Physik / Angewandte Physik, Universität Duisburg-Essen, Lotharstr. 1, D-47048 Duisburg, Germany — [2]COPL, department de physique, génie physique et optique, Université Laval, Québec, Canada G1K7P4

Polycrystalline films of the azo-material DR1 have been investigated. After evaporation on glass substrates the molecules are randomly orientated.

The molecules can be reoriented using different technics. Optically transparent regions may be formed either by light exposure using the Trans-Cis photo-isomerization (optical poling) or by an electrical Corona (electrical poling). The optical anisotropy has been measured by the angular dependence of the absorption-coefficient.

Stable holographic gratings may be recorded as well in the randomly oriented as in the pre-oriented regions. Measuring the topology (AFM or profilometer) indicates a relation between orientational order and material flow.

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Flexible ferroelectret field-effect switches — •Ingrid Graz[1], Martin Kaltenbrunner[1], Christoph Keplinger[1], Reinhard Schwödiauer[1], Siegfried Bauer[1], Stephanie Lacour[2], and Sigurd Wagner[2] — [1]Soft Matter Physics, Johannes Kepler University, Altenberger Str. 69, A-4040 Linz, Austria — [2]Department of Electrical Engineering, Princeton University, Princeton NJ, 08544, USA

Ferroelectrets are internally charged cellular polymers with engineered macroscopic dipoles formed on the internal surfaces of the voids. The strong piezoelectricity of ferroelectrets results in large external electric fields when the mechanical stress acting on the ferroelectret changes. The generated electric field can be used to alter the conductance of the source-drain channel of thin film field-effect transistors (ferroelectret-field effect transistor). We have prepared flexible ferroelectret field-effect switches made of cellular polypropylene films and amorphous silicon thin film transistors. Single element piezoelectric switches, pressure sensors and microphones are demonstrated, which may easily be scaled up to large area, flexible transducer arrays.

CPP 18.4 Wed 16:30 ZEU 114

Thermoplastic Elastomers with Piezoelectric Properties — •Torsten Finnberg, Reza Ghahary, and Bernd-Joachim Jungnickel — Deutsches Kunststoff-Institut, Schlossgartenstrasse 6, 64289 Darmstadt, Germany

The strong piezoelectricity of some polymers results from a favorable combination of permanent polarisation and deformability. The latter may be enhanced by inserting the polarized entities in an elastomeric matrix. We have synthesized thermoplastic elastomers based on poly (ethyl acrylate), PEA, and polyamide-11, PA-11, with a PA-11 content of 30 wt-%. The PA-11 should contribute the ferroelectric polarization, and the PEA ensures the rubber-like elasticity. Due to the low dielectric strength of that material, poling was possible only up to 30 MV/m, and the resulting polarization was caused by dipole orientations in the amorphous phase and the surface of the crystalline phase of the PA-11 rather than being a real ferroelectric remanent polarization. The polarization was nevertheless stable and lead to a quasistatic piezoelectric coefficient of about 1 pC/N. That value exceeded that of about 0.4pC/N of the pure PA-11 as prepared at the same conditions. The results prove that the balance between polarization and deformability in piezoelectric polymers may be shifted to the latter with gain - or at least without loss - in performance but leading to a piezoelectric material with interesting mechanical properties.

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Spatially Inhomogeneous Polarization Switching in Poly(Vinylidene Fluoride) Observed with Focused Thermal Pulses — •Axel Mellinger, Marco Schreiber, Michael Wegener, and Werner Wirges — Department of Physics, University of Potsdam, Am Neuen Palais 10, 14469 Potsdam

Poly(vinylidene fluoride) and its colpoymer with trifluoroethylene are well-known ferroelectric polymers, with numerous applications for piezo- and pyroelectric transducers. However, the dynamics of the electrical poling process is still the subject of intense investigation. Recent progress in the non-destructive, three-dimensional mapping of space-charge and polarization profiles with thermal pulses [1] allows the spatially resolved imaging of the polarization switching process as the material is subjected to periodic electric fields at mHz frequencies. The polarization maps with a lateral resolution of 50 μm and a near-surface depth resolution of better than 0.4 μm reveal a highly inhomogeneous switching, with a partial pinning of the polarization in a 1 μm surface layer.

[1] A. Mellinger, R. Singh, M. Wegener, W. Wirges, R. Gerhard-Multhaupt and S. B. Lang, Appl. Phys. Lett. **86**, 082903 (2005).

CPP 18.6 Wed 17:00 ZEU 114

Insulating to semi-metallic transition of different polymers under low-energy ion bombardment — •Y. Koval, M. S. Alam, and P. Müller — Physikalisches Institut III, Universität Erlangen-Nürnberg, Erwin-Rommel Str. 1, 91058 Erlangen, Germany

It is well known that bombardment of polymers with high-energy ions can transform them from an insulating to a conducting state. On the other hand, low-energy ions are considered to be not suitable for this type of transformation. However, we have found that low-energy ions can be successfully used for a conducting layer formation. Depending on treatment conditions, the conduction mechanism in such layers can vary from hopping of charge carries to semi-metallic behavior. The ultra-small thickness of the conducting layer together with the semi-metal type of conductance can be interesting for polymer electronics technology. Several polymers were investigated in various regimes of low-energy ion bombardment. We present a summary of our recent results.