DF 2: Electric, electromechanical and optical properties I

Time: Monday 10:00–13:00 Location: EB 107

Invited Talk DF 2.1 Mon 10:00 EB 107

Recent Progress in Polymeric LED — •Klaus Meerholz — Physikalische Chemie, Universität Köln, Luxemburgerstr. 116, 50939 Köln

Organic light emitting diodes (OLEDs) based on electroluminescent conjugated polymers are considered as a promising alternative for display and lighting applications, mainly due to their better compatibility with low-cost production techniques and large substrates. A challenge is multiple-layer deposition to improve the efficiency of the devices and, as a result, their lifetime.

This contribution summarizes recent trends in the field of OLED with an emphasis on solution-processed devices. We have in the past developed photochemically crosslinkable semiconductors for fabrication of complex multilayer OLED with a potential for eventually becoming organic lasers and RGB-pixelation [1-2].

[1] C.D. Müller, A. Falcou, N. Reckefuss, M. Rojahn, V. Wiederhirn, P. Rudati, H. Frohne, O. Nuyken, H. Becker, K. Meerholz, Nature 421, 829 (2003). [2] M.C. Gather, A. Köhnen, A. Falcou, H. Becker, Klaus Meerholz, Adv. Funct. Mat. 17, 191 (2007).

DF 2.2 Mon 10:40 EB 107

Molecular hybrids for optical switching — •Andrea Schuy, Theo Woike, and Dominik Schaniel — 1. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln

$(CN_3H_6)_2Fe(CN)_5NO$ (guanidinium nitroprusside = GuNP) has the ability to form metastable isomers with a change of refractive index after irradiation with laser light in the blue-green spectral range. One isomer is formed by a rotation of the NO ligand around 180° to turn the Fe-NO into a Fe-ON coordination. By subsequent irradiation with light in the near infrared spectral range the 180°-ligand rotates around 90° to a side-on position [1]. This ability remains unaffected after embedding $(CN_3H_6)_2Fe(CN)_5NO$ into a silica-gel matrix, even down to dilution to single-molecules. We investigated differences between the behavior of the crystalline GuNP and GuNP embedded in gel due to the effects of complex-complex interactions and complex-matrix interactions respectively on the NO-vibration.

[1] D. Schaniel, M. Imlau, Th. Weisemoeller, Th. Woike, K. Krämer, H. U. Güdel; *Photoinduced nitrosyl linkage isomers uncover a variety of unconventional photorefractive media*; *Adv. Mat.* **19** (5), 723-726 (2007).

DF 2.3 Mon 11:00 EB 107

Hybrid Elastomers with Improved Electromechnical Properities — Torsten Finnberg and •Bernd-Joachim Jungnickel — Deutsches Kunststoff-Institut, Darmstadt, Germany

Dielectric elastomers are a promising material for solid-state actuators due to the high energy density which can be stored, the short response times, and the high obtainable strain. That strain is based on the Maxwell effect. It has the same electric field dependence as electrostriction but is ruled by the ratio between dielectric permittivity and Youngs modulus of the material. A technologically feasible route to optimise the electro-mechanical performance of a dielectric elastomer is consequently to increase its dielectric constant by blending with a high dielectric constant filler without simultaneous increase in stiffness. In doing that, hybrids of polydimethylsiloxane filled with nano-scaled titanium dioxide were prepared. The influence of the filler content on the mechanical, dielectric, and electro-mechanical behaviour was investigated. The dielectric constant increased linearly with filler contents up to 10 wt-%. On the other hand, the elastic modulus of the hybrids decreased slightly in that composition range. The electromechanical coupling coefficient exhibited consequently a maximum for a filler level of 6 wt-% where it increased by 140 % with respect to that of the unfilled material. The approach enables to tune the mechanical and electro-mechanical properties of a dielectric elastomer to a desired ratio.

DF 2.4 Mon 11:20 EB 107

Time- and frequency-domain polarization imaging on poly(vinylidenefluoride-co-trifluoroethylene) films — •Rosaura Flores Suárez[1], Axel Mellinger[1], Werner Wirges[1], Reimund Gerhard[1], Cong-Duc Pham[2], Anca Petre[2], Laurent Berquez[2], and Didier Marty-Dessus[2] — [1]University of Potsdam, Department of Physics, 14469 Potsdam, Germany — [2]Paul Sabatier University, Laboratory on Plasma and Conversion of Energy, 31062 Toulouse, France

Three-dimensional tomography of space-charge and polarization distributions are of high interest for the electrical characterization of new dielectric materials. In this work, two non-destructive thermal methods called TPT (Thermal-Pulse Tomography) and FLIMM (Focused Laser-Intensity Modulation Method) are presented and compared. FLIMM is implemented in the frequency domain, while TPT works in the time domain. In an effort to further increase the lateral resolution while minimizing the thermal stress on the sample, 3D polarization images of poly(vinylidenefluoride-co-trifluoroethylene) (PVDF-TrFE) films poled with a well-defined grid-pattern electrode were obtained. The PVDF-TrFE (65%-35%) films (12 μm thickness) were prepared by means of drop casting. The 3D polarization maps show a polarization starting at a depth of 0.2 μm. In low- and high-resolution scans, the details of the grid electrode are very well reproduced and non-uniformities of polarization along some arms are seen, respectively. These results will be compared with simulations taking into account the 3D heat flow.

DF 2.5 Mon 11:40 EB 107

Cellular polymer ferroelectrets for generation and detection of air-borne ultrasound — •Petr Bartu[1], Mario Dansachmüller[1], Ivan Minev[2], Ingrid Graz[2], Nikita Arnold[1], and Siegfried Bauer[1] — [1]Soft Matter Physics, Johannes Kepler University, Linz, Austria — [2]Nanoscience Centre, University of Cambridge, UK

Charged cellular polypropylene ferroelectrets can be used as sensors and transducers in many applications (e.g. pressure measurements, microphones and loudspeakers). The suitability of different materials for generating and detecting air-borne ultrasound can be compared by means of a figure of merit (fom) $F = k^4/Z^2$, where k and Z denote the materials longitudinal coupling factor and acoustic impedance respectively. By comparison with piezoelectric ceramics and ferroelectric polymers, soft cellular foams possess the largest fom F.

In order to demonstrate the coupling quality of cellular ferroelectrets to air, samples of charged cellular polypropylene are investigated in an acoustical interferometer arrangement in a transmitting as well as in a reflecting mode. Due to the good coupling to air, Fabry-Perot resonances are observed together with the electromechanical thickness extension resonance of the cellular ferroelectret foam. Using a plane wave acoustical model, the observed Fabry-Perot resonances are confirmed and a straightforward derivation of the fom F is presented. Work partially supported by the FWF.

DF 2.6 Mon 12:00 EB 107

Flexible Touch- and Pressure Sensitive Piezo Elastomer Stretch Sensor for Simple Surface Point Location Detection. — •Reinhard Schwödiauer, Christoph Orthwein, Gerda Buchberger, Ingrid Graz, Petr Bathu, and Siegfried Bauer — Soft Matter Physics, Johannes Kepler University, Altenbergerstrasse 69, 4040 Linz, Austria

Mechanical flexibility is a central advantage and an auspicious goal for the branch of macroelectronics, dealing with the development of plastic electronic products and related sensors. In many application fields however, flexibility alone is not sufficient: Examples include technical skin-sensors for robotics or wearable, fabric-integrated large-area sensors. Sensors and actuators in such application fields should be stretchable and not just flexible. Therefore, the development of flexible, touch sensitive sensors is a challenging task in plastic electronics.

We present simple designs for large-area elastomeric touch- and pressure sensors based on cellular polypropylene ferroelectrets in combination with conductive poly(dimethylsilicone). Both the preparation, the morphological characterization as well as the performance of the sensor is discussed. In addition a simple concept is introduced, allowing for spatially localizing single touch events. No complex structured array sensors are required, instead a nonstructured large area ferroelectret is used with electronic elements at the periphery of the device. A simple one-dimensional model is given to elucidate the concept. Experimetal results are used to illustrate the performance of the flexible and stretchable sensor systems.

DF 2.7 Mon 12:20 EB 107

Second Harmonic Generation an ungeordneten, porösen Materialien — •Susanne Lisinski[1], Dominik Schaniel[2], Lorenz Ratke[1] und Theo Woike[2] — [1]DLR, Institut für Materialphysik im Weltraum, Köln, Deutschland — [2]Universität zu Köln, 1. Physikalisches Institut, Köln, Deutschland

Im Rahmen dieser Arbeiten werden ferroelektrische $LiTaO_3$ und $LiNbO_3$ Xerogele mittels eines Sol-Gel Verfahrens synthetisiert und auf ihre frequenzverdoppelnden Eigenschaften untersucht. Die hergestellten Materialien bestehen aus einem Netzwerk ungeordneter, ferroelektrischer Kristallite mit einem einstellbaren Kristallitdurchmessers von 100 nm-3 μm. Second Harmonic Generation (SHG) der porösen Materialien wird mit Hilfe eines gepulsten Nd:YAG Lasers mit einer Wellenlänge von λ_e=1064 nm erzeugt. Die generierte Strahlung ist aufgrund der ungeordneten polaren Achsen der Kristallite diffus. In diesem Vortrag wird die Sol-Gel-Synthese und Charakterisierung der Materialien, wie auch die Abhängigkeit der SHG-Energie von der Probendicke, Kristallitgrösse und Stöchiometrie, vorgestellt.

DF 2.8 Mon 12:40 EB 107

Dynamics of optical degradation on LiB_3O_5-crystal surfaces during SFG — •Stefan Möller, Änne Andresen, and Mirco Imlau — Department of Physics, University of Osnabrück, D-49069 Osnabrück

We have investigated the phenomenon of optical degradation of LiB_3O_5 single crystal surfaces during sum-frequency generation (SFG) of UV-light (λ = 355 nm) by a focused Q-switched Nd:YAG laser (f = 20 kHz, τ_{1064} = 10 ns, $\overline{P}_{1064}$ = 1.5 W). The investigations were performed on timescales > 100 h and UV-intensities below the light induced damage threshold of the crystals. The degradations were studied with optical and analytical methods.

As a result we found a steady deposition of foreign material on the output crystal surface in the illuminated area. Here, XPS uncovered several foreign elements as Na, S, Si, Ca, C beside B and O depending on the composition of the ambient atmosphere during SFG. The temporal development of the degradation could be observed by measuring the beam profile behind the crystal. The beam divergence increased as a function of the deposition height, which led to a complex intensity profile in the far-field. Further illuminating lead to a catastrophic break-down of the surface and the beam profile. This is due to thermal damage originating from the UV-absorption of the deposited material. Three models for the deposition process are discussed: a) diffusion out of the LiB_3O_5-subsurface, b) deposition of atoms of the ambient atmosphere, c) chemical reactions of LiB_3O_5, water, and boric acid. Financial support by the DFG (TFB 13, project A5/13-04).