

CPP 6: Electronic+Optical Properties

Time: Monday 14:00–16:45

Location: C 230

CPP 6.1 Mon 14:00 C 230

Degradation mechanisms due to shading effects on organic solar cell modules — ●ROLAND STEIM^{1,2}, PAVEL SCHILINSKY¹, STELIOS A. CHOULIS^{1,3}, and CHRISTOPH J. BRABEC⁴ — ¹Konarka Technologies GmbH, Landgrabenstrasse 94, D-90443 Nürnberg, Germany — ²Department of Electrical Engineering, University of Karlsruhe, D-76131 Karlsruhe, Germany — ³Cyprus University of Technology, Department of Mechanical Engineering & Materials Science and Engineering, 3603 Lemesos, Cyprus — ⁴Konarka Technologies, Altenbergerstrasse 69, A-4040 Linz, Austria

Organic solar cells based on Polymer:Fullerene blends have an open-circuit voltage in the range of 0.6V. Higher voltages that are needed for efficient sunlight to electrical energy conversion can be achieved by a serial connection of solar cells to modules. The voltage of each cell is added to the module voltage. The single solar cells within the module are dependent from each other and the failing of one solar cell can damage the whole module. We present data based on our investigations on module shading effects on organic solar cells. When shading one cell of a module, the shaded cell acts as load and is driven by the non-shaded ones. The shaded cell is under stress due to the applied reverse voltage and high current. Thus the shaded cell can be degraded as a function of shading time. We have investigated the failing mechanisms of reverse biased organic solar cells. We have identified, localized hot spots influence to the stability of organic solar cells under reverse bias stress. By device engineering modifications we have increased the stability of organic solar cell modules under shading.

CPP 6.2 Mon 14:15 C 230

Solution processable Cs-salt cathode structures for Polymer-LEDs — ●RIIKKA SUHONEN^{1,2}, ANDREAS KANITZ¹, WIEBKE SARFERT¹, RALPH PÄTZOLD³, and ALBRECHT WINNACKER² — ¹Siemens AG, CT MM1, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany — ²Department of Material Science VI, University Erlangen-Nuremberg, Martensstraße 7, 91058 Erlangen, Germany — ³OSRAM Opto Semiconductors GmbH, Leibnizstraße 4, 93055 Regensburg, Germany

The thin layers between the cathode and the polymer in polymer light emitting diodes (PLEDs) have been shown to have a big impact on the final device performance. Usually, in PLEDs low work function metals like Ba, Mg or Ca are used to reduce the energy barrier height between the cathode and the polymer thus providing a better electron injection from the cathode. Due to the high reactivity and quenching properties of these metals, search for electron injecting materials to replace them is ongoing. Recently, several alkali salts like LiF, CsF and Cs₂CO₃ have been shown to efficiently work as an electron injection layer. From these materials especially Cs₂CO₃ has proven to work very efficiently both as an electron injection layer.

In this contribution, we compare the performance of two cesium salts, cesium carbonate (Cs₂CO₃) and cesium stearate (CsSt). Both of these salts can be deposited from solution and by vacuum evaporation. Additionally, both of the salts show comparable or even better performance in comparison to the standard Ba cathode. Also the long term stability of the salt-cathode structures has been investigated.

CPP 6.3 Mon 14:30 C 230

Magnetic field effects on charge carriers in OLEDs — ●ULRICH NIEDERMEIER^{1,2}, WIEBKE SARFERT¹, and HEINZ VON SEGGERN² — ¹Siemens AG, CT MM 1, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany — ²TU Darmstadt, Department of Materials Science, Petersenstr. 23, 64287 Darmstadt, Germany

Magnetic field effects in organic light emitting diodes (OLEDs) have attracted more and more attention in recent research activities. In an external magnetic field both the current flow through an OLED and the light emission from the device are increased. We present results from magnetoresistance measurements suggesting that the presence of triplet excitons within the device is linked to the appearance of the magnetoresistive effect. In fluorescent emitters the effect occurs at voltages above turn-on where both electrons and holes are injected and form excitons. Introducing phosphorescent emitters in a fluorescent matrix results in a decrease of the magnetoresistance effect since triplet excitons are effectively removed from the system by radiative decay. Using different cathode and emitter materials we furthermore

show a dependence of the magnetoresistance on the charge carrier balance within the device. In photoluminescence measurements of fluorescent emitters a magnetic field has no influence since optical excitation creates only singlet excitons. Finally, we discuss our results in the framework of two recently proposed theories on the origin of the organic magnetoresistance effect.

CPP 6.4 Mon 14:45 C 230

Investigation of grating formation in thin layers of an azobenzene-containing diblock copolymer — ●RAFAEL MEINHARDT¹, SVEN MACKO¹, ANSGAR DRAUDE¹, YUE ZHAO², and HILMAR FRANKE¹ — ¹Department of Applied Physics, University of Duisburg-Essen, Duisburg, Germany — ²Département de chimie, Université de Sherbrooke, Sherbrooke, Québec, Canada

A diblock copolymer composed of poly{(ethylene oxide)₄₅} and poly{[6-[4-(4-cynophenylazo)phenoxy]ethyl methacrylate]₅₅} has been synthesized. Thin films (< 800nm) have been prepared from solutions in trichloromethane by gravity settling. Film thickness and changes of the refractive index anisotropy after homogeneous exposure were measured by m-line-spectroscopy and metal film enhanced leaky mode spectroscopy. In a conventional two beam holographic setup gratings with a lateral periodicity of 2000 nm have been generated using an argon ion laser (488nm). An exposure time of a few seconds was sufficient to obtain a grating with first order diffractions exceeding the transmitted 0th order. Different experiments with different polarization configurations have been performed with in situ measurements of the diffraction efficiencies which lead to diffraction efficiencies in the range of 40%. We will demonstrate the formation of a refractive index grating and a surface relief grating with different time constants and quantify their ratio. The formation of surface relief gratings particularly in the initial state has been investigated by performing AFM measurements. Applications for grating coupling, optical switching and tuneable gratings will be presented.

CPP 6.5 Mon 15:00 C 230

Temperature dependent analysis of grating formation on azobenzene polymer films. — ●PADMANABH VEER¹, ULLRICH PIETSCH¹, PAUL ROCHON², and MARINA SAPHIANNIKOVA³ — ¹Department of Solid State Physics, University of Siegen, ENC, 57068, Siegen, Germany — ²Department of Physics, Royal Military College, Kingston, Ontario, Canada K7K5L0 — ³Leibniz Institute of Polymer Research, 01069, Dresden, Germany

The temperature dependence of surface relief grating formation was studied using continuous and pulse like exposure. Surface relief gratings were inscribed on amorphous azobenzene polymer thin films using a holographic pattern of circularly polarized light at wavelength equal to 514 nm in a vacuum chamber to avoid the hot air turbulence and probed using a He-Ne laser of wavelength 633 nm by monitoring the first order diffraction peak (I₁) as well as the specular reflected intensity (I_s). Under continuous exposure permanent grating formation was observed up to a temperature of about 100 °C only. The same was found under pulse like exposure but grating still exists as long as the actinic light is on. Above 100 °C it relaxes entirely after switching the light off. Our findings can be interpreted by the competition between light-induced ordering of azobenzene side chains and temperature induced disorder. Because the accumulated stress within the polymer decreases with temperature, permanent grating formation can only be observed when the light-induced stress is above the yield stress. (Reference-Accepted Paper-P. veer1, U. Pietsch1, P. Rochon2, and M. Saphiannikova3 Molecular crystal and liquid crystal.)

break

CPP 6.6 Mon 15:30 C 230

Furan-bridged fullerenes - a new class of organic semiconductors? — ●MARKUS REINMÖLLER, UWE RITTER, and WICHARD J. D. BEENKEN — Technische Universität Ilmenau, Institut für Physik

We performed quantum-chemical calculations of different oxygen-bridged C₆₀-dimers. The calculations on relaxed structures have shown that a furan-like linkage is preferred. For this structure we found an anti-binding - insulating HOMO, whereas the LUMO may be conducting for a delocalized binding orbital between the two fullerenes.

Unexpectedly, this orbital is not related to the oxygen but located on the opposite side - quasi free-hanging outside the furan-bridge. This result engaged us to investigate longer chains of several furan-bridged fullerenes, which may turn out as new organic semiconductor.

CPP 6.7 Mon 15:45 C 230

Localized Charge Transfer in a Molecularly Doped Conducting Polymer — ●EMAD F. AZIZ¹, ANTJE VOLLMER¹, STEFAN EISEBITT¹, WOLFGANG EBERHARDT¹, PATRICK PINGEL², DIETER NEHER², and NORBERT KOCH³ — ¹BESSY GmbH, Berlin, Germany — ²Universität Potsdam, Potsdam, Germany — ³Humboldt-Universität zu Berlin, Berlin, Germany

Upon doping conjugated polymers can become highly conductive and thus important for the further development of all-organic optoelectronic devices. However, very little is known about the nature of donor/acceptor charge transfer (CT) in molecularly doped conjugated polymers. We present evidence for localized CT complex formation between the prototypical organic donor poly(3-hexylthiophene) (P3HT) and the molecular acceptor tetrafluoro-tetracyano-quinodimethane (F4TCNQ) in thin films by combining X-ray absorption near edge structure (XANES) measurements with theoretical modeling using density functional theory (DFT). This CT leads to molecular distortions and self-localization of the new hybrid energy levels on short single polymer chain segments.

E. F. Aziz, A. Vollmer, S. Eisebitt, W. Eberhardt, P. Pingel, D. Neher, N. Koch, *Adv. Mater.* 2007, 19, 3257-3260

CPP 6.8 Mon 16:00 C 230

Characterization of optical active nanostructures on silicon — ●THOMAS BAUMGÄRTEL, HARALD GRAAF, and CHRISTIAN VON BORCZYKOWSKI — Center of Nanostructured Materials and Analytics, TU Chemnitz, 09107 Chemnitz, Germany

It has been recently demonstrated, that nanostructures can be functionalized in a neat way through selective binding of dye molecules and nanoparticles [1]. Anchoring optically active molecules on nanostructured surfaces is a promising step towards building complex structures with variable properties and functions.

In our contribution we report on the characterization of nanostructures on silicon, that have been optically functionalized by binding of cationic dyes. The structures have been generated by local anodic oxidation of alkyl-terminated silicon via AFM. Due to the oxidation process, these silicon oxide structures are partially negatively charged. The cationic dyes rhodamine 6G and cresyl violet have been attached to the structures via electrostatic interactions and were studied using wide-field and confocal microscopy. A change in luminescence spectra of the dyes on the nanostructures, compared to the dyes in solution has been found. Furthermore, the bleaching behaviour of the dyes bound to the structure has been investigated.

[1] H. Graaf, M. Vieluf, and C. von Borczykowski, *Nanotechnology* 18, 265306 (2007)

CPP 6.9 Mon 16:15 C 230

Spectroscopic and Electrochemical Investigation of Tubular J-Aggregates During Photo-Assisted Growth of Silver —

●DÖRTHE M EISELE¹, CONSTANS WEBER¹, JENNIFER LYON³, HANS V. BERLEPSCH², STEFAN KIRSTEIN¹, CHRISTOPH BÖTTCHER², KEITH J STEVENSON³, DAVID A VANDEN BOUT³, and JÜRGEN P RABE¹ — ¹Humboldt University Berlin — ²Free University Berlin — ³University of Texas at Austin

Cyanine dye J-aggregates have been intensively investigated as sensitizers for photo induced electron transfer processes and are used in photographic films to form elementary silver specks in solid silver halide crystallites. Of particular interest are tubular J-aggregates formed by amphiphilic cyanine dye molecules upon self assembly aggregation in aqueous solution. A detailed understanding of their physicochemical properties is necessary for applications as spectral sensitizers in artificial light harvesting systems.

In this contribution, this light accelerated electron transfer from the tubular aggregates to noble metal ions such as silver is studied. This photo assisted charge transfer induces the growth of metallic nanoparticles that are located on the J-aggregate surface and does not disrupt the long-range tubular morphology. The reduction of the silver is observed by monitoring the oxidation of the J-aggregate using absorption and emission spectroscopy. Independent spectro-electrochemical investigations also show that the reduction of silver is associated with an oxidation of the cyanine dyes.

CPP 6.10 Mon 16:30 C 230

Photoinduced Formation of N₂ Molecules in Ammonium Compounds — ●EMAD FLEAR AZIZ¹, JOHAN GRASJO², JOHAN FORSBERG³, EGIL ANDERSSON³, JOHAN SÖDERSTRÖM³, LAURENT DUDA³, WENHUA ZHANG⁴, JINGLONG YANG⁵, STEFAN EISEBITT¹,

CHRISTEL BERGSTRÖM², YI LUO⁴, JOSEPH NORDGREN³, WOLFGANG EBERHARDT¹, and JAN-ERIK RUBENSSON¹ — ¹BESSY GmbH, Berlin, Germany — ²Department of Pharmacy, Uppsala University, Sweden — ³Department of Physics, Uppsala University, Sweden — ⁴Theoretical Chemistry, Royal Institute of Technology, Stockholm, Sweden — ⁵Hefei National Laboratory of Physical Sciences, at the Microscale, University of Science and Technology of China

Via fluorescence yield (FY) and resonant inelastic scattering spectroscopy in the soft X-ray range we find that soft X-rays induce formation of N₂ molecules in solid NH₄Cl and in related compounds. The nitrogen molecules form weak bonds in NH₄Cl, so that a substantial fraction of the molecules remains in the sample. From measurements of the FY as a function of exposure and temperature, the rates for the photochemical processes are estimated. At elevated temperatures (363 K), several nitrogen atoms are removed from the sample per incoming photon. At lower temperatures (233 K), the rate is reduced to around 0.02 nitrogen atoms for each incoming photon. Virtually all these atoms form N₂ molecules which are bound in the sample. The generality and implications of these results are briefly discussed.

Emad F. Aziz, et. al. *J. Phys. Chem. A* 111, 9662-9669 (2007)