

## HL 29: Organic Photovoltaics II: mainly Phtalocyanine

Time: Monday 17:45–18:45

Location: FOE Anorg

HL 29.1 Mon 17:45 FOE Anorg

**Band gap states of copper phthalocyanine thin films induced by nitrogen exposure** — ●TOMOKI SUEYOSHI<sup>1,2</sup>, HARUYA KAKUTA<sup>1</sup>, MASAKI ONO<sup>1</sup>, KAZUYUKI SAKAMOTO<sup>1</sup>, SATOSHI KERA<sup>1</sup>, and NOBUO UENO<sup>1</sup> — <sup>1</sup>Graduate School of Advanced Integration Science, Chiba University, Chiba, Japan — <sup>2</sup>Peter Grünberg Institut (PGI-3), Forschungszentrum Jülich, 52425 Jülich, Germany and JARA-Fundamentals of Future Information Technology

Extensive experimental and theoretical investigations have demonstrated the strong correlation between electronic and structural properties of organic layers. Although understanding of this correlation is very crucial, the question whether the intrinsic or externally induced disorder in the molecular packing structure influences their electronic properties remains obscure.

Here we investigated impact of 1-atm N<sub>2</sub> gas exposure on the electronic states of copper phthalocyanine thin films using ultrahigh-sensitivity ultraviolet photoelectron spectroscopy. The highest occupied molecular orbital band of the film showed a drastic reversible change in the bandwidth and band shape as well as in the energy position upon repeated cycles of N<sub>2</sub> exposure and subsequent annealing. Furthermore, two types of gap-state densities with Gaussian and exponential distributions appeared after the exposure and disappeared due to the annealing. These changes are ascribed to a weak disorder in the molecular packing structure induced by N<sub>2</sub> diffusion into the film.

HL 29.2 Mon 18:00 FOE Anorg

**Influence of temperature and illumination on the photo-voltage of organic solar cells** — ●JOHANNES WIDMER, WOLFGANG TRESS, KARL LEO, and MORITZ RIEDE — Institut für Angewandte Photophysik, TU Dresden, George-Bähr-Straße 1, 01069 Dresden

Temperature plays an essential role in many processes in organic devices, including the current and voltage generation in organic solar cells. In this contribution, we focus on the open-circuit voltage of organic solar cells when varying illumination intensity and temperature in the range of 200K to 400K. Zinc phthalocyanine (ZnPc) and C<sub>60</sub> are used as reference system and other materials are investigated in comparison to demonstrate the connection between the effective energy gap and the open-circuit voltage of a photovoltaic device. The use of doped transport layers in a p-i-n diode geometry allows to minimize the energetic losses between the active layers and the contacts and gives access to the quasi Fermi levels in the heterojunction. We can verify the dependence between the effective gap of a heterojunction and the open-circuit voltage. A substantial difference, however, is observed comparing the interplay of temperature and illumination intensity of bulk and flat heterojunction devices. Classic photo-diode like behaviour is observed for the open-circuit voltage of bulk heterojunction devices, as described by generation-recombination dynamics. In the case of a flat heterojunction, however, the influence of tempera-

ture and illumination become independent, which is not covered by the established theory. These findings can contribute to the understanding of the photo-voltage of organic devices.

HL 29.3 Mon 18:15 FOE Anorg

**Open circuit voltage as function of mixing ratio in ZnPc:C60 bulk heterojunction organic solar cells** — ●STEFFEN PFUETZNER, WOLFGANG TRESS, SELINA OLT Hof, MAX TIETZE, JAN MEISS, KARL LEO, and MORITZ RIEDE — Institut für Angewandte Photophysik, Technische Universität Dresden, D-01069 Dresden, Germany

We characterize organic solar cells composed of mixed layers of ZnPc:C<sub>60</sub> as photoactive layer embedded between a p-doped hole transport (HTL) and an undoped electron transport layer. By varying the mixing ratio of the photoactive bulk heterojunction from 6:1 (ZnPc:C<sub>60</sub>) to 1:6 by volume, we observe significant changes of V<sub>OC</sub> from 0.54 to 0.63 V. To exclude that this increase with higher C<sub>60</sub> content is caused by the increased contact area of C<sub>60</sub> to the HTL, behaving as an additional exciton separating interface, *J(V)* measurements under spectral narrow red and blue illumination are performed. Independent of where absorption takes place (for red in ZnPc, for blue in C<sub>60</sub>), V<sub>OC</sub> is not affected significantly. Hence, we attribute the changes in V<sub>OC</sub> not to an additional separating interface, but to an intrinsic blend layer effect. Further investigations using ultraviolet photoelectron spectroscopy measurements, absorption measurements, and HTL variations with different highest occupied molecular orbitals indicate as reason HOMO and LUMO shifts of C<sub>60</sub> and ZnPc as a function of the mixing ratio.

HL 29.4 Mon 18:30 FOE Anorg

**In-situ characterization of molecular semiconductor donor-acceptor-blends** — LENA KRISTIN CORNELIUS, ●MAX BEU, and DERCK SCHLETTWEIN — Institute of Applied Physics, Justus-Liebig-University Giessen, Germany. email:schlettwein@uni-giessen.de

Blends of *F<sub>16</sub>PcCu* and *PcCu* were prepared on glass by physical vapour deposition. The acquired thin films had a thickness of around 20nm. The co-evaporation of *PcCu* and *F<sub>16</sub>PcCu* was varied to obtain different molecular mixtures. High admixture of *PcCu* to *F<sub>16</sub>PcCu* as typically used in bulk-hetero-junctions were compared to very low admixtures typical for dopant interactions. The current-voltage characteristics were studied during evaporation (in-situ). High levels of *PcCu* in *F<sub>16</sub>PcCu* (moderate per cent range) disturbed the charge flow in the films. Very little admixture of *PcCu* in the low per mille range, however, led to an increased conductivity, indicating a successful dopant interaction. Optical transmission spectroscopy consequently showed the disturbance of the *F<sub>16</sub>PcCu* solid state structure. The dominant  $\beta_{bilayer}$ -structure of pure *F<sub>16</sub>PcCu* (highly conductive) was partly changed to the herringbone  $\beta$ -structure (less conductive). Consequences for photoconduction in the films will be discussed.