

## DS 53: Organic Electronics and Photovoltaics IV (jointly with CPP, HL, and O)

Time: Thursday 16:15–17:45

Location: GER 38

DS 53.1 Thu 16:15 GER 38

**Energy level alignment at polymer/PCBM heterojunctions under operating conditions in an organic photovoltaic cell structure** — ●JOHANNES FRISCH<sup>1</sup>, ANDREAS WILKE<sup>1</sup>, PATRICK AMSALEM<sup>1</sup>, JENS NIEDERHAUSEN<sup>1</sup>, ANTJE VOLLMER<sup>2</sup>, and NORBERT KOCH<sup>1</sup> — <sup>1</sup>Humboldt-Universität zu Berlin, Institut für Physik, Brook-Taylor-Str. 6, D-12489 Berlin, Germany — <sup>2</sup>Helmholtz-Zentrum Berlin für Materialien und Energie - Speicherring BESSY II, Berlin, Germany

For heterojunction organic photovoltaic cells (OPVCs) generally vacuum level alignment at the donor/acceptor interface is assumed. In contrast, it has been shown that interface dipoles might occur at organic/organic heterojunctions, which questions the assumption of vacuum level alignment at OPVC interfaces. Therefore, we investigated the energy level alignment at the poly(3-hexylthiophene)/1-(3-methoxycarbonyl)propyl-1-phenyl[6.6]C61 (P3HT:PCBM) heterojunctions with ultraviolet photoelectron spectroscopy (UPS). The valence band of P3HT shifted to higher binding energy by 0.45 eV after deposition of PCBM, while vacuum level alignment was found. This observation would imply an increase of the P3HT ionization energy upon interface formation, which is usually not considered in simple models. The observed phenomenon can be explained either by a structural rearrangement of the donor polymer layer upon acceptor deposition or by surface photovoltage effects that occur during photoemission, which charges the P3HT layer positively whereas negative charges are collected in the PCBM layer.

DS 53.2 Thu 16:30 GER 38

**New Imaging Approach for Organic Bulk Heterojunction Solar Cells Using Selective Dissolution** — ●BETTINA FRIEDEL, BRUNO EHRLER, and NEIL C. GREENHAM — University of Cambridge, Cavendish Laboratory, JJ Thomson Avenue, CB30HE Cambridge, United Kingdom

Morphology in organic photovoltaic devices is one of the most vital and most studied issues for optimum functionality, especially concerning bulk heterojunctions. However, it is always a challenge to control its microscopic structure towards improved exciton dissociation and charge transport. To get an insight into this microstructure usually a combination of various imaging techniques together with spectroscopic methods is used. Unfortunately imaging on all-organic structures is rather challenging since the high similarity of the carbon-based materials gives low contrasts and makes them hard to distinguish. We will present a new imaging approach for organic blends, based on a temperature controlled selective dissolution technique. We will demonstrate on two systems (polymer-polymer and polymer-PCBM) that this technique allows to selectively remove one of the components from a bulk heterojunction, leaving a scaffold of the other component, which can be easily characterized by high resolution imaging, due to the higher air-material contrast. Further the technique allows us to quantify the disordered fraction of semicrystalline components in a blend structure, which is valuable information for matters of charge transport. These new structural insights help understanding the changes in PV performance e.g. following thermal treatments or using solvent additives.

DS 53.3 Thu 16:45 GER 38

**Improvement of the CdSe/P3HT solar cells efficiency due to surface modification of the CdSe nanoparticles by alkyamine treatments** — ●NIKOLAY RADYCHEV, IRINA LOKTEVA, HOLGER BORCHERT, JOANNA KOLNY-OLESIK, and JÜRGEN PARISI — Institute of physics, energy and semiconductor research laboratory, university of oldenburg, oldenburg, germany

Semiconductor quantum dots (QDs) continue to attract immense attention because of their size-dependent optical, physical, and chemical properties which causes them to be a promising material for hybrid solar cell applications. Meanwhile QDs in a polymer matrix have to be stabilized by organic ligands that show significant influence on the charge transport and charge separation processes. Surface modification procedures such as stabilizing ligand exchange or crosslinking the QDs can enhance the efficiency of the hybrid blends. In the present work, as-synthesized QDs, initially capped with oleic acid, were subjected to ligand exchange procedures with the intention to obtain nanoparticles capped by butylamine ligands. Detailed characterisations of the buty-

lamine stabilized QDs based on thermogravimetric analysis, nuclear magnetic resonance and transmission electron microscopy are shown. Laboratory solar cells with blends of the butylamine capped CdSe QDs and poly-3-hexylthiophene (P3HT) as active layer were prepared and investigated by current-voltage and external quantum efficiency measurements. Energy conversion efficiency of about 2% was obtained. The fundamental reasons of the efficiency enhancement were analyzed

DS 53.4 Thu 17:00 GER 38

**Comparison of the operation of standard and inverted P3HT:PCBM solar cells** — ●THOMAS J.K. BRENNER, YANA VAYNZOF, ZHE LI, DINESH KABRA, RICHARD H. FRIEND, and CHRISTOPHER R. MCNEILL — Cavendish Laboratory, Department of Physics, University of Cambridge, JJ Thomson Ave., Cambridge CB3 0HE, United Kingdom

Inverted organic solar cells have attracted recent attention due to their enhanced environmental stability compared to the standard device architecture. However to date inverted cells have shown poorer efficiencies compared to the standard geometry. To clarify the origin of this behaviour, we have investigated inverted (ITO/ZnO/P3HT:PCBM/WO<sub>3</sub>/Ag) and regular (ITO/PEDOT:PSS/P3HT:PCBM/Al) P3HT:PCBM solar cells with different active layer thickness. Using white light bias external quantum efficiency and photocurrent transient measurements, we propose an explanation for the reduced performance of inverted cells. Whereas for inverted devices high EQEs of up to 68% are measured under low light intensities (3 mW/cm<sup>2</sup>), EQE drops with increasing white light bias (up to 140 mW/cm<sup>2</sup>) down to 20%. This drop is accompanied by a severe distortion of the spectra. For increased thickness (from 90 nm to 550 nm), the drop and shape change can be seen at lower intensities. For regular devices we also observe a drop in EQE, however they still resemble the absorption spectrum showing minor distortion. Unbalanced charge transport and/or unfavourable vertical phase separation in inverted devices are presented as likely causes of the observed behaviour.

DS 53.5 Thu 17:15 GER 38

**Organic Photovoltaic Cells with Pentacene Nanocolumn Arrays** — ●SHUWEN YU, PETER SCHÄFER, JÜRGEN P. RABE, and NORBERT KOCH — Institut für Physik, Humboldt-Universität zu Berlin, Brook-Taylor-Str. 6, 12489 Berlin, Germany

Highly ordered pentacene nanocolumn arrays were fabricated by glancing angle deposition (GLAD) on indium tin oxide (ITO) substrates. The nanocolumn diameter was set to 100–150 nm as revealed by scanning electron microscopy and atomic force microscopy. Interdigitated bulk heterojunction photovoltaic cells (OPVCs) were formed by spin-coating [6,6]-phenyl-C61-butyric acid methyl ester (PCBM) as the acceptor material onto the pentacene nanocolumn film. Bathocuproine (BCP) was deposited on top of PCBM as exciton blocking layer. The conversion efficiency of nanocolumn-based OPVCs was significantly higher compared to planar heterojunction OPVCs of the same materials. Further device performance improvement was achieved through employing a thin pentacene seed layer before GLAD, which promoted PCBM solution infiltration between pentacene nanocolumns.

DS 53.6 Thu 17:30 GER 38

**Performance and stability of P3HT/PCBM bulk heterojunction organic solar cells** — ●NIVEDITA YUMNAM, SIDHANT BOM, and VEIT WAGNER — School of Engineering and Science, Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany

Organic photovoltaic cells are promising candidates for large-area, low-cost production of solar cells. However, the low stability in conjunction with their medium performance is one of the major drawbacks in comparison to their inorganic counterparts. In this investigation environmental conditions for degradation of bulk heterojunction P3HT/PCBM solar cells are systematically analyzed over a period of one week. Devices were prepared by spin coating from different compositions of P3HT and PCBM in Chlorobenzene (C<sub>6</sub>H<sub>5</sub>Cl). Performance parameters, efficiency and I-V characteristics were determined in a N<sub>2</sub> glove box showing optimized efficiency for a 1:1 ratio. Degradation behavior in N<sub>2</sub> atmosphere, vacuum and solvent-enriched atmosphere (Chlorobenzene) showed best results for vacuum stored solar cells while

for solvent-enriched atmosphere rapid degradation was observed. Remarkable degradation (open-circuit voltage and short-circuit current reduced to 90% and 60% after one week) was also found for N<sub>2</sub> atmosphere of the glove box used for the solar cell production. Residual

solvent vapor left dispersed in the atmosphere of the glovebox after the spin coating process is identified as an important parameter of this degradation.