MSE-Colloquium@NTU

4 August 2017, 4.00 pm

Lecture Theatre 3, Nanyang Technological University

Molecular Acceptors for Organic Solar Cells: Photophysics, Performance and Lifetime in Comparison to Fullerenes

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About the Talk

Organic semiconductors are in general known to have lower mobility compared to the inorganic counterparts. As such, the bimolecular recombination rate of holes and electrons, usually referred to as Langevin recombination, is typically an important loss mechanism. Here, we elucidate the photophysics of BHJ solar cells based on a non-fullerene acceptor (NFA) in combination with various polymers showing an unprecedentedly low bimolecular recombination rate despite unbalanced charge carrier mobility. NFA´s have evolved quickly over the last years. On the one hand they show competitive efficiencies of up to 13 %, which is competitive to fullerene based solar cells. On the other hand, many of the NFAs do not seem to form a charge transfer (CT) state between the donor and acceptor, thus enabling open circuit voltages as high as 1.3 V.

We investigate a particular NFA based on an IDTBR molecule and observed high FF (above 65%) which we could attributed to the non-Langevin behaviour with a beta/beta L ratio of 1x10-4. We calculated high charge carrier lifetimes without parasitic recombination in P3HT:IDTBR solar cells, leading to an almost perfect bimolecular recombination. Most interestingly, light intensity mobility measurements reflect a strongly non-thermalized carrier transport, indicating the origin of this unusual slow recombination kinetics. As a consequence, we varied the active layer thickness of the devices between 80 nm and 450 nm and found a thickness- independent PCE, which is a most desired prerequisite for industrial applications. First investigations on NFAs show that a least one photo-induced degradation process is absent. Dimerization, as known from [60] fullerenes, does not play a major role in NFAs so far. Even more, many of the NFA composites investigated showed amazingly stable microstructures. The absence of demixing in the amorphous phase allowed to demonstrate solar cells with thousand´s of hours photostability and no burn-in.

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About the Speaker

Christoph J. Brabec is holding the chair "**m**aterials for **e**lectronics and **e**nergy **t**echnology (*i-MEET*)" at the materials science of the Friedrich Alexander University Erlangen-Nürnberg.

Further, he is the scientific director of the Erlangen division of the Bavarian research institute for renewable energy (ZAE Bayern, Erlangen), board member of the ZAE Bavaria and board member of the Energy Campus Nurnberg. He received his PhD (1995) in physical chemistry from Linz university, joined the group of Prof Alan Heeger at UCSB for a sabbatical, and continued to work on all aspects of organic semiconductor spectroscopy as assistant professor at Linz university with Prof. Serdar Sariciftci. He joined the SIEMENS research labs as project leader for organic semiconductor devices in 2001, finished his habilitation in physical chemistry in 2003 at Linz university and joined Konarka in 2004, where he was holding the position of the CTO before joining university.

He is author and co-author of more than 300 papers and nearly 100 patents and patent applications and has Hirsch index of > 70. His research interests are (i) organic photovoltaics, (ii) all aspects of solution processed semiconductors and (iii) technologies for renewable energy scenarios.

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