TECHNISCHE UNIVERSITÄT DRESDEN

Bereich Mathematik und Naturwissenschaften Fachrichtung Physik

PHYSIKALISCHES KOLLOQUIUM

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Thema: **On the Role of Spin States in Donor-Acceptor based Solar Cells and Light Emitting Diodes**

Zeit und Ort: Dienstag, 22.11.2016, 16:40 Uhr
Recknagel-Bau, Hörsaal REC/C213, Haeckelstr. 3

Leiter: Prof. Dr. Sebastian Reineke

Kurzfassung: A strategy for increasing the conversion efficiency of organic photovoltaics has been to increase the V_{OC} by tuning the energy levels of donor and acceptor components. However, this opens up a new loss pathway from an interfacial charge transfer state (CTS) to a donor triplet exciton (TE) state called electron back transfer (EBT), which is detrimental to device performance. To test this hypothesis, we study triplet formation in high performing blends of the fullerene $PC_{70}BM$ with either the polymer PTB7 or the soluble small molecule p-DTS$(FBTTh_2)_2$ and determine the impact of the morphology-optimizing additive 1,8-diiodoctane (DIO). Using photoluminescence and spin-sensitive optically detected magnetic resonance (ODMR) measurements at low temperature, we find that fullerene TEs form via intersystem crossing (ISC) from singlet excitons and on donor materials via EBT mechanism. At 300 K, however, no triplets are detected via ODMR, and electrically DMR on optimized solar cells indicates that TEs are only present on the fullerenes for PTB7 based blends, while in p-DTS$(FBTTh_2)_2$ based solar cells, both, donor and acceptor TEs can be detected. We conclude that at least in these solar cells, EBT does not represent a dominant loss pathway under device operation conditions.

Similar measurements were performed on TADF light-emitting devices, exploiting the mechanism of up-conversion of non-radiative triplet- to radiative singlet states in fluorescent donor-acceptor blends. We found a direct contribution of weakly bound triplet exciplex states to EL being of reverse ISC type. This process is strongly temperature dependent and we observed a crossover from recombination of weakly bound exciplex states to strongly bound triplet excitons, i.e. from RISC to direct ISC mechanism by lowering the temperature and may thus exclude a direct contribution of TEs to TADF.

Kurzbiographie: Andreas Sperlich studied Physics in Würzburg and got his PhD in 2013 (advisor: Vladimir Dyakonov). Since 2013, he is group leaser for Spin Physics. In 2016, he was guest scientist at the Boehme Group in Salt Lake City and at the Argonne National Laboratory (Chicago). His research interests cover organic photovoltaics, OLEDs, carbon nanotubes, spin defects in silicon carbide, optical spectroscopy, and magnetic resonance.

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