The Ilmenau Expertise in Organic Photovoltaics

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The Ilmenau group has a longstanding expertise in optical, structural and electrical characterization of organic semiconductors and photovoltaic devices made thereof. Predominant characterization techniques employed in our group are:

- spectroscopic ellipsometry (SE) → determination of the optical properties such as the dielectric function or the complex (anisotropic) refractive index[1, 2]
- photoinduced absorption respectively reflection (PIA) → determination of charge carrier densities, lifetimes and mobilities[3, 4]
- photoluminescence spectroscopy (PL) → determination of characteristic emission spectra and efficiency of photoluminescence quenching in photovoltaic blends[5]
- X-ray diffraction → determination of crystallinity of organic thin films in the grazing incidence geometry[6, 7]

Furthermore, as a member of IMN and user of the central clean-room facilities of our university, we have access to atomic force microscopy, transmission and scanning electron microscopy. The TU-An-Institute TITK Rudolstadt yields further technological expertise. In all of the above mentioned techniques we have a deep experience in the application to organic semiconductors and blend films and thus we gained a lot understanding in structure-property relationships such as correlations between crystallinity and absorption coefficient[8], influence of thermal treatments (annealing) on structural, optical and electrical properties in polymer solar cells[5, 7] and ordering effects in thin polymeric films[9].

A second large field of expertise lays in the preparation and characterization of polymer solar cells and solar modules. Our characterization is done by standard current-voltage (IV) and highly-sensitive External Quantum Efficiency (EQE) measurements. Here we could recently demonstrate competitive power conversion efficiencies on solar cells with an active area of 0.5 cm² by application of optical modelling based optimization of polythiophene-fullerene blends[10]. Furthermore we gained expertise in up-scaling the solar cells active area by a factor of ten to more than 5 cm² and monolithic integration into solar cell modules showing very competitive efficiencies. In addition we are devoted to studying new materials and material systems (for example fullerene derivatives in close cooperation with Dr. Pavel Troshin, IPCP-RAS, Chernogolovka, Russia) investing and expanding our expertise in the fields of morphology[11, 12] and structure-property relationships down to the molecular scale[12].

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