

Charge Transfer and Transport in Polymer-Fullerene Solar Cells

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Z. Naturforsch. **57 a**, 995–1000 (2002); received September 20, 2002

The development of polymer-fullerene plastic solar cells has made significant progress in recent years. These devices excel by an efficient charge generation process as a consequence of a photo-induced charge transfer between the photo-excited conjugated polymer donor and acceptor-type fullerene molecules. Due to the paramagnetic nature of the radical species, the photo-induced charge transfer can be analyzed by the help of light-induced electron spin resonance spectroscopy. Upon looking at an interpenetrating donor-acceptor composite consisting of the polymer MDMO-PPV and the fullerene derivative PCBM, we disclose two well separated line groups having a strongly anisotropic structure. The line shape can be attributed to an environmental axial symmetry of the polymer cation and a lower rhombohedral symmetry of the fullerene anion. Since the signals were found to be independent of one another with different spin-lattice relaxation times, the radical species can be discriminated via separate characterization procedures. In order to study the bulk charge transport properties, we carried out admittance spectroscopy on the polymer-fullerene solar cell device including a transparent semiconductor oxide front contact (ITO/PEDOT:PSS) and a metal back contact (Al). The temperature- and frequency-dependent device capacitance clearly uncovers two different defect states, the first, having an activation energy of 9 meV, indicates a shallow trap due to a bulk impurity, the latter, having an activation energy of 177 meV, can be assigned to an interfacial defect state located between the polymer-fullerene composite and the metal back contact.

Key words: Organic Solar Cell; Fundamentals; Characterization.