INVESTIGATION OF CURRENT LIMITING MECHANISMS WITHIN POLYMER-FULLERENE SOLAR CELLS

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The efficiency of polymer solar cells is currently within the range of 2.5 – 3.5%. To improve this power efficiency, it is imperative to understand the loss mechanisms within the cells. We report on the losses in current occurring at the metal – semiconductor interface, as well as those occurring in the bulk of these devices.

Diodes were fabricated from the individual components of the cell to investigate the losses occurring at the semiconductor/electrode interface. The thickness of the diodes was varied, as well the metals used for electrodes, to investigate the transition from injection dominated to bulk dominated currents through the devices. The injection currents were analysed according to an already existing hopping model.

Bulk limitations in the solar cells were further investigated in the context of the temperature and light intensity dependence of the main cell parameters. As shown in fig. 1, the strong temperature dependence of the J_{SC} reflects the transport losses due to trapping and recombination of charge carriers. Such behaviour was established recently for bulk-heterojunction devices based on absorber materials with low charge carrier mobility (polyparaphenylene-vinylene derivative, OC1C10-PPV blended with the fullerene PCBM, [1]). In contrast, in solar cells based on higher mobility polymers (poly (3-hexylthiophene 2.5-diyl) (P3HT) blended with PCBM) the J_{SC}, which is thermally activated at low temperatures, saturates and becomes nearly temperature independent at higher temperatures (Fig. 1b), clearly indicating that the charge carriers traverse the active layer without significant losses [2,3].

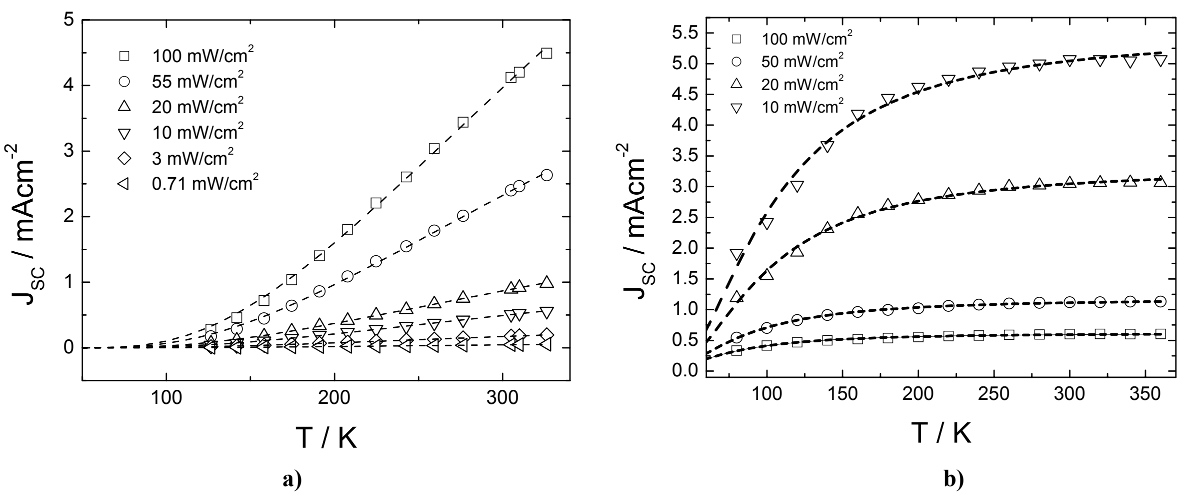

Figure 1. Short circuit current density J_{SC} as a function of temperature and light intensity for ITO/PEDOT:PSS/PPV:PCBM/Al **(a)** and for ITO/PEDOT:PSS/P3HT:PCBM/Al **(b)** solar cells.

1) I. Riedel, V. Dyakonov, J. Parisi, L. Lutsen, D. Vanderzande, J. C. Hummelen, Adv. Funct. Mat. 14, 38 (2004).
2) V. Dyakonov, I. Riedel, J. Parisi, European Material Research Society Conference, Strasbourg, France (2003).
3) P. Schilinsky, C. Waldauf, I. Riedel, V. Dyakonov, C. J. Brabec, Adv. Mat. (submitted) (2003).

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