Effect of illumination intensity and temperature on transport properties in organic solar cells

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The development and synthesis of new materials used as electron donors or acceptors, optimization in the manufacturing process and a better understanding of the physical phenomena that involves from the absorption of light by donor material until the extraction charges by electrodes have allowed the increase in the conversion efficiency of the organic solar cells, where currently the maximum conversion efficiency obtained is around 13%¹. It is imperative to know the temperature dependence of transport properties in organic solar cells, mainly that of the bulk heterojunction type (BHJ), to improve their performance and stability. In this work we present a dc and ac study in a ITO/PEDOT:PSS/PTB7-Th:PC₇₁BM/Ca-Al solar cell structure, both under dark and illumination conditions, across a wide temperature range of 100–320 K. We also varied the intensity of illumination, where the intensity of a one sun (100 mW/cm²) was the maximum used intensity, and we studied the dependence of the short-circuit current ($J_{sc}$) with the lighting intensity ($I$). We obtained the relation $J_{sc} \propto I^a$, where $0.5 \leq a \leq 1$ as reported by other authors ². The analysis of these results, carried out at different temperatures, allowed us to correlate a with the value of the charge carrier mobility. By combining impedance and time-transient measurements of photovoltage and charge carrier extraction, we explored how the lifetime of the photocarriers varies with temperature and lighting intensity, and we also were able to infer values for the recombination coefficient reduction factor.

References