Charge Accumulation and Internal Photovoltaic Processes in Organic Solar Cells

HUldong Zang, Yu-Che Hsiao, Qing Liu, University of Tennessee, Ilia Ivanov, Oak Ridge National Laboratory, Bin Hu, University of Tennessee — The accumulation of dissociated charge carriers plays an important role in reducing the loss occurring in open-circuit voltage (Voc), short-circuit photocurrent (Isc), fill factor (FF) in organic solar cells. We found from light-assisted capacitance measurements that the charge accumulation inevitably occurs at device interfaces in bulk-heterojunction ITO/PEDOT/P3HT:PCBM/Ca/Al solar cells. Our experimental studies have indicated that the charge accumulation can reduce the Voc through charge injection, Isc through charge collection, and FF through charge transport. Furthermore, our light-assisted capacitance measurements reveal that using a dielectric thin film of TiOx can decrease charge accumulation in the ITO/PEDOT/P3HT:PCBM/TiOx/Ca/Al solar cell. In particular, we find that decreasing the charge accumulation can reduce the loss occurring in Voc, Isc, and FF. Clearly, controlling charge accumulation presents a new mechanism to improve photovoltaic performance in organic solar cells.

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