Area: Organic and Dye-Sensitized Solar Cells.

IMPROVED V_{OC} IN SMALL MOLECULE ORGANIC SOLAR CELLS WITHOUT CONCOMMITANT DECREASE IN J_{SC}

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Organic solar cells (OSCs) based on low molecular weight donor and acceptor molecules – so-called small molecule OSCs (SMOSCs) – have made a substantial improvement in their performance in recent years and are now achieving power conversion efficiencies (PCEs) that match those achieved of polymer:fullerene OSCs. To date, all efficient SMOSCs have relied on the same fullerene acceptor, PCBM, in order to achieve high performance. The use of PCBM however, is unfavourable due to its low-lying lowest occupied molecular orbital (LUMO) that limits the open-circuit voltage (V_{OC}). Alternative fullerene derivatives with higher LUMOs are thus required to improve the V_{OC} and should, in theory, improve the PCE. Unfortunately, for fullerene derivatives with high LUMOs, there is generally a significant concomitant decrease in the short circuit current density (J_{SC}) when PCBM is replaced. P3HT is the "exception to the rule", with most fullerene derivatives demonstrating high performance when blended with P3HT but much poorer performances are observed when they are tested with low-bandgap donors. Recently, we have demonstrated the first non-PCBM fullerene that shows improved performance over PBCM in SMOSCs.[1] The fullerene derivative, methano indene fullerene, MIF, is a bis-functionalised C60 fullerene that has a LUMO energy 140 mV lower than PCBM. Blending it with a well known small molecule donor, DPP(TBFu)$_2$, in solution processed SMOSCs, we achieved a PCE of 5.1%, which is higher than that of reference DPP(TBFu)$_2$:PCBM devices (4.5%). The improved PCE stems from an improved V_{OC} (1.03 V vs. 0.89 V) and similar J_{SC} values (9.5 mA/cm^2 vs. 10.0 mA/cm^2) and no significant differences in fill factor. XRD and AFM studies showed that MIF shows excellent miscibility with DPP(TBFu)$_2$ and does not hinder the crystalline growth of the donor, which is key for achieving high J_{SC} values. Furthermore, I will discuss the origin of the V_{OC} in SMOSCs in more detail by comparing several recent results obtained in our lab using transient optoelectronic characterization techniques such as charge extraction and transient photovoltage.

1. *Scientific Reports*, **5**, 8319
2. *Adv. Energy Mater.*, **DOI:** 10.1002/aenm.201601509