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Increased Open-Circuit Voltage and Efficiency in Small Molecule Organic Solar Cells Through the Use of a 56-π Electron Acceptor – Methano Indene Fullerene

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Small molecule organic solar cells (SMOSCs) have made great strides in recent years and efficiencies are now on par with their polymer:fullerene counterparts.[1,2] However, in all efficient solution processed bulk heterojunction (BHJ) SMOSCs to date the fullerene acceptor has been $PC_{71}BM$, which is unfavorable as it has a relatively low lying LUMO that minimizes the open-circuit voltage (V_{OC}). (V_{OC} is proportional to the difference between the HOMO of the donor and LUMO of the acceptor). This approach however has proved far from trivial in the case of polymer:fullerene devices, where a concomitant decrease in the short-circuit current density (J_{SC}) is typically observed with most polymer donors blended with high-LUMO fullerene derivatives.[3,4]

Here we demonstrate the application of a high-LUMO 56-π fullerene derivative, methano indene fullerene (MIF), in SMOSCs using a dikettopyrrolopyrrole donor ($DPP(TBFu)_2$. MIF comprises of asymmetrical adducts where one adduct is indene and the other is dihydromethano and has previously demonstrated high efficiencies with P3HT.[5] $DPP(TBFu)_2$:MIF devices are found to have a much improved V_{OC} (1.03 V) without any significant decrease in the J_{SC} (9.5 mA/cm^2), which allows efficiencies of 5.1% to be obtained. In comparison $DPP(TBFu)_2$:$PC_{61}BM$ devices showed a V_{OC} of 0.88 V, J_{SC} = 10.1 mA/cm^2 and an efficiency of 4.5%. Atomic force microscopy and x-ray diffraction studies show that $DPP(TBFu)_2$:MIF form a well intermixed BHJ and MIF does not hinder the growth or crystallinity of $DPP(TBFu)_2$.

(1) Kyaw, A. K. K.; Wang, D. H.; Gupta, V.; Zhang, J.; Chand, S.; Bazan, G. C.; Heeger, A. J. *Advanced Materials* **2013**, *25*, 2397.

(2) Liu, Y.; Chen, C.-C.; Hong, Z.; Gao, J.; Yang, Y.; Zhou, H.; Dou, L.; Li, G. *Sci. Rep.* **2013**, *3, 3356*.

(3) Hoke, E. T.; Vandewal, K.; Bartelt, J. A.; Mateker, W. R.; Douglas, J. D.; Noriega, R.; Graham, K. R.; Fréchet, J. M. J.; Salleo, A.; McGehee, M. D. *Advanced Energy Materials* **2013**, *3*, 220.

(4) Faist, M. A.; Shoaee, S.; Tuladhar, S.; Dibb, G. F. A.; Foster, S.; Gong, W.; Kirchartz, T.; Bradley, D. D. C.; Durrant, J. R.; Nelson, J. *Advanced Energy Materials* **2013**, *3*, 744.

(5) Matsuo, Y.; Kawai, J.; Inada, H.; Nakagawa, T.; Ota, H.; Otsubo, S.; Nakamura, E. *Advanced Materials* **2013**, *25*, 6266.