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Probing the morphology of novel non-fullerene based bulk heterojunction solar cells GREGORY SU, TOAN PHO, FRED WUDL, EDWARD KRAMER, MICHAEL CHABINYC, University of California, Santa Barbara — Organic semiconductors are promising for low-cost, large-area electronics such as organic photovoltaics (OPVs). OPVs require an active layer that is an intimate mixture of an electron donor, usually a conjugated polymer, and an electron acceptor, typically a fullerene. While fullerene-based OPVs show high efficiencies, the inability to tune its electronic levels limits the open circuit voltage, so alternative acceptors are desirable. Here, we report on blend films consisting of a polymer donor, poly(3-hexylthiophene) (P3HT), and a novel acceptor, decacyclene triimide (DTI), that display good solar power conversion efficiencies (PCE) as-cast. The PCE of these blends decreases significantly with thermal annealing, unlike P3HT:fullerene blends. NEXAFS spectroscopy and grazing incidence wide angle X-ray scattering suggest the PCE decrease is due to the formation of hexagonally packed DTI columns with an in-plane π-π stacking direction, resulting in poor electron transport out-of-plane. Polarized resonant soft X-ray scattering suggests that the π-π stacking directions are orthogonal at interfaces between DTI and P3HT domains. These results demonstrate the importance of blend morphology in OPV efficiency and key differences between DTI-based and fullerene-based blends.

Gregory Su
University of California, Santa Barbara

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