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Correlating morphology and device physics of high open circuit voltage, low-band gap all polymer solar cell using various characterization tools.

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The microstructure and device physics of photovoltaic polymer blends based on the donor polymer BFS4 (a dithienyl-benzo[1,2- b:4,5-b]dithiophene / 5-fluoro-2,1,3-benzothiadiazole co-polymer) paired with the naphthalene diimide-based acceptor polymer P(NDI2OD-T2) will be presented. Efficiencies of over 4% are demonstrated, with an open circuit voltage of greater than 0.9 V achieved. Near-edge x-ray absorption fine-structure (NEXAFS) spectroscopy and atomic force microscopy (AFM) measurements reveal that the top surface of BFS4:P(NDI2OD-T2) blends is covered with a pure BFS4 capping layer. XPS Depth profiling measurements confirm this vertical phase separation with a surface-directed spinodal decomposition wave observed. Grazing-incidence wide-angle x-ray scattering (GIWAXS) measurements confirm that BFS4 and P(NDI2OD-T2) are semicrystalline with both polymers retaining their semicrystalline nature when blended. Transmission electron microscopy reveals a relatively coarse phase-separated morphology, with elongated domains up to 200 nm in width. Photoluminescence spectroscopy reveals incomplete photoluminescence quenching with as much as 30% of excitons failing to reach a donor/acceptor interface Addition of DIO as solvent improves the fill factor of the devices from 0.46 to 0.54, thus improving the overall efficiency from 3.9% to 4.5%. Effect of addition of DIO in the neat polymers and blends is also studied using NEXAFS and GIWAXS techniques. NEXAFS and GIWAXS measurements were performed at the Australian Synchrotron, Soft X-ray and SAXS/WAXS beamlines respectively.

Keywords or phrases (comma separated)

OPV, Morphology, GIWAXS, NEXAFS

Summary

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