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Phase purity in organic solar cells BRIAN COLLINS, ELIOT GANN, LEWIS GUIGNARD, North Carolina State University, XIAOXI HE, CHRISTOPHER MCNEILL, University of Cambridge, HARALD ADE — To date, the device function of organic bulk heterojunction solar cells has been commonly interpreted to arise from two interpenetrating, phase-separated donor and acceptor materials with charge separation of excitons occurring at discrete interfaces. However, little attention has been paid to phase purity and the consequences of a mixed phase on the operation of devices. To probe this possibility and its implications, the miscibility of common fullerenes in (3-hexylthiophene) (P3HT) and a number of new low bandgap polymers including PCDTBT have been measured directly via x-ray absorption spectroscopy in a scanning transmission x-ray microscope on films brought to thermodynamic equilibrium. A mixed amorphous phase is always observed, along with a fullerene-rich phase and possibly a pure crystalline polymer phase if the polymer is able to crystallize. For example, grazing incidence x-ray scattering shows no intercalation of fullerenes into P3HT crystallites, while amorphous portions of the polymer contain ~ 20 wt.% of the fullerene. In fact, all systems tested to date have failed to exhibit a pure amorphous polymer phase, suggesting that the device paradigm of pure phases and discrete interfaces requires modification.

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