Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

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 $\sim$20 wt.% of the fullerene. In fact, all systems tested to date have failed to exhibt a pure amorphous polymer phase, suggesting that the device paradigm of pure phases and discrete interfaces requires modification.

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Date submitted: 27 Nov 2010 Electronic form version 1.4