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Correlating the efficiency and nanomorphology of polymer blend solar cells utilizing resonant soft x-ray scattering HONGPING YAN, BRIAN COLLINS, ELIOT GANN, NCSU, CHENG WANG, ALS, HARALD ADE, NCSU, CHRISTOPHER MCNEILL, Monash Univ — Enhanced scattering contrast afforded by resonant soft x-ray scattering (R-SoXS) is used to probe the nanomorphology of all-polymer solar cells based on blends of the donor poly(3-hexylthiophene) (P3HT) with the acceptor either poly((9,9-dioctylfluorene)-2,7-diyl-alt-[4,7-bis(3-hexylthien-5-yl)-2,1,3- benzothiadiazole]- 2',2"-diyl) (F8TBT) or poly([N,N'- bis(2-octyldodecyl)-11 naphthalene-1,4,5,8- bis(dicarboximide)- 2,6-diyl]- alt-5,5'- (2,2'-12 bithiophene)) (P(NDI2OD-T2)). A bimodal distribution of domain sizes is observed for P3HT:P(NDI2OD-T2) blends with small domains of $\sim$ 5 - 10 nm that evolve with annealing and larger domains of $\sim$ 100 nm insensitive to annealing. P3HT:F8TBT blends in contrast show a broader distribution but with the majority structured on 10 nm length scale. For both blends an evolution in device performance is observed, correlated with a coarsening and purification of domains on the 5 - 10 nm length scale. Grazing-Incidence Wide Angle X-ray Scattering (GI-WAXS) reveals 25 - 40 nm thick P(NDI2OD-T2) crystallites embedded in the larger domains observed by R-SoXS. A higher degree of P3HT crystallinity is observed in blends with P(NDI2OD-T2) compared to F8TBT. The propensity of the polymers to crystallize in P3HT:P(NDI2OD-T2) blends is also observed to hinder the morphological development on the sub-10 nm length scale. More broadly, this work also highlights the complementarity of R-SoXS and GI-WAXS.

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