In-situ studies of organic photovoltaic active layer formation and stability

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Organic photovoltaic devices are a promising route to lower costs via roll-to-roll manufacturing. The most promising device architecture involves a bulk heterojunction (BHJ) active layer in which nano-scale phase separation into nominally bicontinuous donor and acceptor rich regions enables both exciton dissociation and charge extraction. The performance of BHJ based devices is a strong function of the active layer processing conditions and the optimized device structure is, in general, not the equilibrium structure. Photon based techniques, such as spectroscopic ellipsometry and grazing incidence x-ray diffraction, can provide detailed insights into film thickness, composition, and microstructure. We will discuss highlights from real-time studies of film formation where mechanisms by which small amounts of solution additives control final polymer crystallinity and nanostructure are revealed. Additionally we will discuss insights into the underlying diffusion dynamics and mixing characteristics of typical donor polymers and acceptor fullerenes by studies of the temperature dependent stability of model bilayer interfaces.