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Controlling Active Layer Morphology in Polymer/Fullerene Solar Cells SUCHANUN MOUNGTHAI, NIKHILA MAHADEVAPURAM, GILA STEIN, University of Houston — The active layer in most polymer solar cells is based on the bulk heterojunction (BHJ) design. BHJs are prepared by arresting the phase separation of a polymer/fullerene blend to produce a nanoscale, interpenetrating network. Such non-equilibrium structures are very difficult to control and reproduce, posing a significant challenge for fundamental structure-property investigations. We demonstrate a new approach to control the active layer morphology with a simple two-step process: First, a thin film of poly(3-hexylthiophene) (P3HT) is cross-linked into stable nanostructures or microstructures with electron-beam lithography [1]. Second, a soluble fullerene is spun-cast on top of the patterned polymer to complete the heterojunction. Significantly, irradiated P3HT films retain good optoelectronic properties and bilayer P3HT/fullerene heterojunctions yield power-conversion efficiencies near 0.5%. We have performed preliminary studies with model nanostructured devices and we find that efficiency increases with interfacial area [2]. These model devices are very valuable for fundamental studies because the interfacial area is accurately measured with small-angle X-ray scattering, and the active layer can be "deconstructed" for imaging with atomic force microscopy.

[1] S. Holdcroft, Adv. Mater. 2001, 13, 1753-1765.
[2] He et al., Adv Funct. Mater. 2011, 21, 139-146.

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