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Kinetically Trapped Morphologies in Organic Photovoltaics

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Controlling the morphology in the active layer of organic photovoltaic (OPV) devise is key in optimizing the performance. To this end, bicontinuous morphologies with characteristic length scales of several tens of nanometers of the electron and hole conducting materials, where the order and orientation of both components are optimized to absorb light over the broadest possible range of the visible spectrum and to transport holes and electrons, after exciton dissociation, Yet, these morphologies are trapped in morphologies that are far removed from equilibrium where multiple kinetic processes, including ordering, phase separation, and the segregation of components to interfaces are arrested as solvent, co-solvents and additives are removed during the preparation of the active layer. Time resolved hard x-ray scattering, resonance soft x-ray scattering and high resolution transmission electron microscopy, along with mobility and transport measurements, have been used to understand the parameters that lead to the development of and can be used to control the morphology of the active layers. In addition, by using ternary mixtures of two polymers active in different parts of the solar spectrum along with an electron transporting material, like PCBM, morphologies can be developed to further enhance the efficiency of these devices.