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Abstract for an Invited Paper
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Pushing structural limits to reveal fundamental mechanisms of organic solar cell operation[1]

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Organic-based solar cells are beginning to emerge with the potential to compete with other thin film photovoltaic technologies, with efficiencies of 12% recently demonstrated. Unique to the function of organic photovoltaics are the creation of tightly bound excitons that can only be efficiently separated at a donor/acceptor (D/A) interface capable of providing the necessary energetic driving force for dissociation. The consequences of this are the need for long exciton diffusion lengths and the presence of charge transfer (CT) states, ground state complexes that exist at the D/A interface. We have found that charge transfer states are more easily separated into free charge if they are delocalized; an aspect that becomes most feasible for highly ordered systems. I will discuss our recent efforts to template and control film morphology and molecular orientation. These studies allow us to understand the importance of molecular orientation, crystallite size, and crystal phase. We will show templated devices utilizing neat films as well as bulk heterojunctions, with crystallite dimensions spanning from the more standard nano-sized grains to those with highly ordered micron-sized crystalline domains revealing unprecedented thin film exciton diffusion lengths of 100s of nm. In these highly ordered films, owing to significant delocalization, we are able to directly measure photocurrent from multiple CT states, an aspect which has important consequences for the design of more efficient photocurrent generation.

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