

Understanding Organic Solar Cell Performance with Electrical Scanning Probes

David S. Ginger

Department of Chemistry, University of Washington

Organic composites comprising blends of conjugated polymers with fullerenes, nanocrystals, or other polymers make promising materials for low cost photovoltaic applications. Different processing conditions are known to impact the efficiency of these blended solar cells by creating a variety of nanostructured film morphologies. However, the relationship between local film structure and device efficiency is not fully understood. We apply time-resolved Electrostatic Force Microscopy (trEFM) and photocurrent conducting Atomic Force Microscopy (pcAFM) to study photoinduced charge generation and transport with resolutions better than 50 nm in several model organic semiconductor device structures under photoexcitation. We show that our trEFM measurements and pcAFM can correlate local variations with the overall external quantum efficiencies for several blend systems, providing a direct link between local morphology, local optoelectronic properties, and device performance. We show that in some systems domain interfaces visible in topographic AFM lead to reduced photocurrent, while in other blends, such features lead to elevated photocurrents. We explain these differences in terms of local compositional and structural variations, and discuss how this improved understanding of microscopic charge generation, recombination and transport can be used to improve the design of blended organic solar cells.