



Plastic Solar Cells: Examining an Isolated Electron Transport Network

Darcy Wanger, Alex Ayzner, and Benjamin Schwartz

Department of Chemistry and Biochemistry, UCLA

Organic solar cells hold great promise for cost-effective power production, but their power-conversion efficiency must double from their current state (~5%) before they become a worthwhile investment. The standard system in the field uses poly(3-hexylthiophene) (P3HT) as the light absorbing polymer and phenyl-C61-butyric-acid-methyl-ester (PCBM) as the electron transport phase. It is believed that annealing increases the crystallinity and therefore interchain stacking in the P3HT, leading to better absorption of light and charge transport. The effect of annealing on the fullerene network is not understood. We have replaced the P3HT with an electronically-insulating but chemically similar polymer, polystyrene (PS), to examine the current-voltage behavior of the fullerene network alone. For the concentration of PCBM comparable to that of the optimized P3HT/PCBM device, we find that the maximum current is significantly lower in the annealed film than the unannealed film. This suggests that fullerenes are well distributed throughout the film when cast, but aggregate into islands when allowed to move within the film under annealing conditions. Decreased fluorescence quenching of P3HT/PCBM devices after annealing supports this assertion. Annealing therefore hinders the electron transport network because fullerene islands act as carrier traps rather than facilitating charge flow. If annealing helps the polymer but hinders the fullerene network, there is room for improvement in the fullerene derivative used. The development of a fullerene derivative that is unaffected or benefited by the annealing process may allow it to improve the power-conversion efficiency of the device more dramatically.

Word count: 242