



Optimization of Polymer Solar Cell in Conjunction with Small Molecules

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Solid-state solar cells based on organic semiconductors have attracted much interest because of the motivation for developing inexpensive, efficient and renewable energy sources. The current best polymer solar cell uses Poly(3-hexylthiophene):[6,6]- phenyl C₆₁-butyric acid methyl ester (P3HT:PCBM) and gives a power conversion efficiency of around 4-5 %. Though promising, organic solar cells still need to be improved in order to match commercialized silicon solar cell panels, which operate at greater than 14% in efficiency. One possible way to improve device efficiency involves extending the ability of the cell to absorb into infrared (IR) range. Here, a new device structure is fabricated combining the current P3HT:PCBM model either with zinc phthalocyanine (ZnPc) or with copper phthalocyanine (CuPc). Phthalocyanine materials are organic semiconductors that have excellent hole mobility and absorb light in the solar spectrum outside that of P3HT: PCBM. According to our results, adding Pc materials actually decreases efficiency; this is due to the fact that Pc materials have very poor electron mobility and that the thickness necessary for good absorption hinders charge carrier dissociation. This discovery provides critically important guidance for designing organic solar cell materials. One must bear in mind that the materials must simultaneously satisfy at least two requirements: optical and electronic. To satisfy optical requirements, the materials must have proper band gaps and band position. Electronically, the materials must have proper charge carrier mobility. Our device structure still bears the potential to overcome existing efficiency limitations if materials with better electron mobility and longer exciton diffusion length are used.