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# Enhancement of Power Conversion Efficiency from Controlled Nanostructure in Polymer Bulk-Hetero Junction Solar Cells

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Polymer-fullerene based bulk heterojunction (BHJ) solar cells can be fabricated in large area using low-cost roll-to-roll manufacturing methods. However, because of the low mobility of the BHJ materials, there is competition between the sweep-out of the photogenerated carriers by the built-in potential and recombination within the thin BHJ film [12-15]. Useful film thicknesses are limited by recombination. Thus, there is a need to increase the absorption by the BHJ film without increasing film thickness. Metal nanoparticles exhibit localized surface plasmon resonances (LSPR) which couple strongly to the incident light. In addition, relatively large metallic nanoparticles can reflect and scatter the light and thereby increase the optical path length within the BHJ film. Thus, the addition of metal nanoparticles into BHJ films offers the possibility of enhanced absorption and correspondingly enhanced photo-generation of mobile carriers. In this work, we have demonstrated several positive effects of shape controlled Au and Ag nanoparticles in organic P3HT/PC70BM, PCDTBT/PC70BM, Si-PCPDTBT/PC70BM BHJ-based PV devices. The use of an optimized concentration of Au and Ag nanomaterials in the BHJ film increases Jsc, FF, and the IPCE. These improvements result from a combination of enhanced light absorption caused by the light scattering of the nanomaterials in an active layer. Some of the metals induce the plasmon light concentration at specific wavelength. Moreover, improved charge transport results in low series resistance.

**Keywords:** Solar Cells, Organic, High efficiency