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Luminescent and Conductive Cathode Buffer Layer for Enhanced Power Conversion Efficiency of Bulk-Heterojunction Solar Cells

Authors : Swati Bishnoi, D. Haranath, Vinay Gupta

Abstract : In this work, we demonstrate that the power conversion efficiency (PCE) of organic solar cells (OSCs) could be improved significantly by using ZnO doped with Aluminum (Al) and Europium (Eu) as cathode buffer layer (CBL). The ZnO:Al,Eu nanoparticle layer has broadband absorption in the ultraviolet (300-400 nm) region. The Al doping contributes to the enhancement in the conductivity whereas Eu doping significantly improves emission in the visible region. Moreover, this emission overlaps with the absorption range of polymer poly [N -9′-heptadecanyl-2,7-carbazole-alt-5,5-(4′,7′-di-2-thienyl-2′,1′,3′-benzothiadiazole)] (PCDTBT) significantly and results in an enhanced absorption by the active layer and hence high photocurrent. An increase in the power conversion efficiency (PCE) of 6.8% has been obtained for ZnO: Al,Eu CBL as compared to 5.9% for pristine ZnO, in the inverted device configuration ITO/CBL/active layer/MoOx/Al. The active layer comprises of a blend of PCDTBT donor and [6-6]-phenyl C71 butyric acid methyl ester (PC71BM) acceptor. In the reference device pristine ZnO has been used as CBL, whereas in the other one ZnO:Al,Eu has been used as CBL. The role of the luminescent CBL layer is to down-shift the UV light into visible range which overlaps with the absorption of PCDTBT polymer, resulting in an energy transfer from ZnO:Al,Eu to PCDTBT polymer and the absorption by active layer is enhanced as revealed by transient spectroscopy. This enhancement resulted in an increase in the short circuit current which contributes in an increased PCE in the device employing ZnO: Al,Eu CBL. Thus, the luminescent ZnO: Al, Eu nanoparticle CBL has great potential in organic solar cells.

Keywords : cathode buffer layer, energy transfer, organic solar cell, power conversion efficiency
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