A ZrO_2: ZnO blend electron injection layer in inverted photodiodes for achieving low dark current and high detectivity

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The effect of zirconium oxide as electron injection layer (EIJ) has been verified in studies on light emitting diodes. Ultraviolet photoelectron spectroscopy (UPS) data shows that valence band level in zirconium oxide is formed considerably lower than that of zinc oxide. In this study, we introduced ZrO2:ZnO blend as an electron injection layer, which can also function as an efficient hole blocking layer. From ultraviolet photoelectron spectroscopy analyses, we showed that systematic tuning of the energy level could be achieved by varying the blend ratio. As a result, the ZrO2:ZnO blend film with optimal mixture ratio allowed both efficient electron injection from the cathode to the active layer and also effectively suppressed hole injection from the active layer to the cathode under reverse saturation regime of photodiode. Photodiode structured as ITO/ZrO2:ZnO/active layer/MoOx/Ag showed remarkably enhanced detectivities compared to the case of conventional ZnO-based device, up to 1013 Jones with apparently low dark current down to ~10-8 A/cm2. Detailed physics behind the observed improvement were fully discussed in conjunction with various morphological/structural analyses.