Transparent Cathode for White Top Emitting Organic Light Emitting Diodes

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Micro-cavity effect [1] can be generated between the strongly reflective anode for the top side emissive method and the semi-transparent metal cathode. This cavity effect between two metal mirrors amplifies the emitted light intensity at the selective wavelength and suppresses other spectral region. It disturbs the fabrication of white top emitting organic light emitting diodes (TEOLEDs) with the broad spectra. Therefore, white TEOLEDs need to use the low reflectance as well as the high transmittance cathode. We already reported the highly transparent thin silver (Ag) cathode (ETL/Ag/WO_3) with about 80 % transpmittance and also found that this thin silver layer worked well as the mirror in spite of its high transmittance. [2] As the altertive transparent electrode, Al: MoO_3 mixed layer as the cathode buffer for organic photovoltacis was reported with the control of the transmittance and work-function. [3]

In this paper, we report a new transparent cathode structure for white TEOLEDs. To suppress the micro-cavity effect in TEOLED, herein we mixed Ag and high refractive index metal oxide materials, such as WO_3 and MoO_3, with various ratios. The sample structure for the measurement of transmittance was ETL(20 nm)/mixed layer (Ag : WO_3 or MoO_3). Co-deposited Ag with oxide materials might show island state which could give rise to scattering effect and we believe that it may suppress the micro-cavity effect. Fig. 1. (a) shows the transmittance and sheet resistance of metal oxide material mixed Ag layers (12 nm). The MoO_3 mixed Ag layer shows better transmittance and sheet resistance characteristics. Just 10 % of WO_3 mixed Ag layer shows the average transmittance of 38 % for the wavelength of 400 nm to 750 nm and the sheet resistance of 1,140 Ω/□. However, 50 % MoO_3 mixed Ag layer has the transmittance of 58.4 % and the sheet resistance of 724 Ω/□. When the thickness of mixed layer is increased from 12 nm to 18 nm, the sheet resistance is reduced to 49 Ω/□ with the transmittance loss of only 3 %. In order to enhance the transmittance of 5 % (12 nm) and 50 % (18 nm) MoO_3 mixed layers, the organic capping layer (CL) of 60 nm was deposited. Hence, the transparent cathode structure with CL shows the enhanced transmittance from 54.2 % to 69.4 % and from 55 % to 62.5 %, respectively (Fig. 1.(b)). Detailed optimization ways on highly transparent cathode for white TEOLEDs and the optical design as well as their fabrication will be discussed in the presentation.

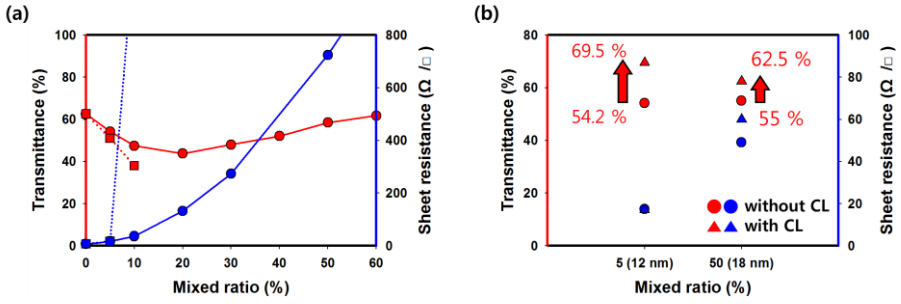

Fig. 1. (a) Mixed ratio vs. transmittance (red) and sheet resistance (blue) of MoO_3 (circle) and WO_3 (square) mixed Ag layer. (b) Organic capping layer effect of 5 % MoO_3 mixed Ag layer (12 nm) and 50 % MoO_3 mixed Ag layer (18 nm).

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