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Abstract
Indium tin oxide (ITO) transparent conductive film has been widely used in flat panel display industry for its excellent optical and electrical properties. However, several ITO film properties need to be improved for organic light-emitting diode (OLED) applications, such as the ITO surface work function and roughness.
Our previous study have demonstrated that by doping nickel (Ni) into ITO film the characteristics of OLED devices can be largely improved. This is because Ni or NiOx appears at ITO/Organics interface, give a higher work function (> 5.0 eV) than that of normal ITO (~4.6 eV). This study tends to dope platinum (Pt) atoms into ITO matrix with a co-sputter method to elevate ITO surface work function. The introduction of Pt is based on the idea that the work function of Pt (5.4 eV) is higher than that of Ni (5.0 eV). The influence of the Pt-doped ITO on characteristics of OLED device will be investigated.
The OLED device consists of substrate/ normal ITO/ Pt-doped ITO(x nm)/ NPB(20nm)/ Alq3(35nm) / LiF(0.05 nm)/ Al(100nm) structure. The Pt-doped ITO film was first deposited by co-sputtering of Pt (r.f. power) and ITO (d.c. power) targets with Pt sputter power raring in the range of 0 – 50 W to yield various atomic concentration of Pt in the ITO film. Double heterojunction OLED devices were fabricated with the Pt-doped ITO anode on commercial ARTON substrate and commercial ITO substrate to investigate its effects on electro-optical characteristics of the devices. The fabrication of the device began with the deposition of Pt-doped ITO contact anode in a co-sputter system, followed by the depositions of organic layers, NPB and Alq3 in a thermal evaporation chamber. After that, LiF as a buffer layer and Al as a cathode were subsequently deposited using e-beam evaporation. To investigate the effect of surface states, Pt-doped ITO films were also treated with oxygen plasma before the device processing.
Results show that, the sheet resistance and the optical transmittance deteriorate as the r.f. sputter power and thickness increases. This is due to that the interstitial doping induced lattice scattering and strong electron shielding effect. For this reason, only was the Pt-doped ITO (10W) film suitable used as the anode for the following fabrication of OLED device. ITO films incorporated with Pt exhibited lower surface roughness and potential barrier than the undoped ITO film. Results reveal that with a Pt-doped ITO anode, OLED device generally exhibit better opto-electrical characteristics, on both the commercial ARTON and commercial ITO substrates. This is due to that introduced Pt atoms increase ITO surface work function and lower potential barrier at ITO/NPB interface.
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