Improved Stability of Organic Light-Emitting Diodes using Nickel Oxide doped PEDOT:PSS

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Poly(ethylenedioxythiophene) doped with poly(styrenesulfonate) (PEDOT :PSS) is one of the most interesting and studied materials in optoelectronic devices for its high conductivity, high transparency in the visible range and high workfunction[1]. It has been widely used as hole injection layer (HIL) on top of the anode in organic light-emitting diodes (OLEDs). However, PEDOT :PSS have several limitations especially that the nature of its acidity affects the organic/inorganic interface, leading to device failure[2]. Therefore, transition oxide materials such as MoO_3 and WO_3 have been used to avoid this problem [3-4]. Here, we have investigated the effect of sol-gel nickel-oxide (NiO_x) doping in PEDOT:PSS (PEDOT:PSS:NiO_x), specifically in terms of the OLED device stability.

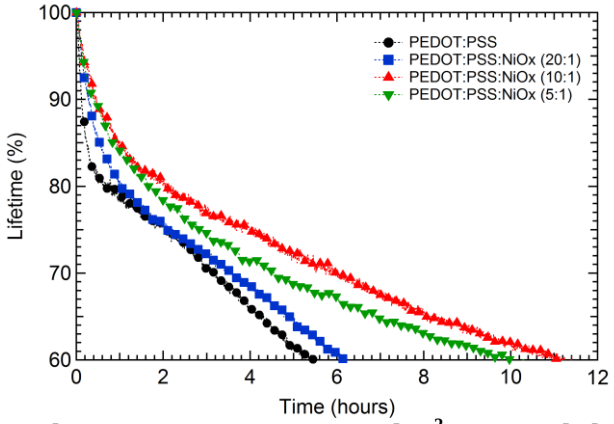

Fig. 1. Lifetime of green phosphorescent OLEDs at 2000cd/m^2 using nickel-oxide doped PEDOT:PSS as HIL with different doping concentrations

NiO_x thin films are p-type and transparent semiconductor with a band gap energy in the range of 3.6-4.0eV. The sol-gel processed NiO_x has a deep LUMO level above 2eV which can be stable in air without being oxidized. Therefore, we have adopted sol-gel NiO_x doped in PEDOT:PSS to improve OLED device stability. The effect of NiO_x doping in PEDOT:PSS have been demonstrated using green phosphorescent emitter tris[2-phenylpyridinato-C2]iridium(Ⅲ) ($Ir(ppy)_3$) doped in 4, 4′-Bis(N-carbazolyl)-1,1′-biphenyl (CBP) with different NiO_x doping concentrations. The device stability was measured through operation lifetime, fixing the initial luminance at 2000cd/m^2 and supplying constant current to each device (Fig. 1). The device with 10:1 volume ratio of PEDOT:PSS:NiO_x exhibited extrapolated half-lifetime (LT50) of 14.3 hours, improving the operation lifetime nearly 200% compared to that of reference PEDOT:PSS (LT50 = 7.5 hours).

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