Efficient Green Cuprous-Based OLEDs Using a High Triplet Energy Host

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Though the economical and environmental considerations make phosphorescent Cu^{I} complexes far more attractive than those noble metal complexes as emitters for OLEDs, their relatively low electroluminescent efficiency is problematic. In fact, many of these complexes have high photoluminescence (PL) efficiency in a solid state. For example, the PL efficiency of green emissive [Cu(dnbp)(DPEPhos)](BF_4) (**1**) in a PMMA film with the concentration of 10 wt% is about 60%, comparable to that of Ir(ppy)$_3$ (70%). However, the maximum external EL quantum efficiency (EQE) of its device, ITO/PEDOT/10wt% **1**:PVK/BCP/Alq$_3$/LiF/Al is only 3%,[1] is one third of the similar device based on Ir(ppy)$_3$. Recently, we found that the PL efficiency of **1** in a PVK or CBP film is significantly lower than that in a PMMA film due to the back transfer of triplet energy from guest to host. This phenomenon does not occur in Ir(ppy)$_3$/CBP system, but was observed in blue emitting phosphorescent complexes, such as FIrPic.[2] The PL efficiency of **1** in various hole transport materials was measured. As shown in Fig. 1, it is a function of the triplet energy of the host materials, and only the host material with the triplet energy higher than 2.93 eV can avoid the back energy transfer completely, indicating that the triplet energy of this green light-emitting Cu^{I} complex is even higher than that of blue light-emitting FIrPic.[2] Similar result was found in another green emissive Cu^{I} complex, [Cu(μ-I)dppb]$_2$,[3] that has the same PL spectrum as **1**. Obviously, the triplet level of these phosphorescent materials cannot be simply determined by the peak of their spectra. Instead, the onset of their spectra may lead to a more comparable result (Fig. 2). Utilizing the high triplet energy compound, PYD-2Cz and SPPO1, as the host and HBL, respectively, we improved the maximum EQE of the device described above from 3% to 8%. This efficiency is comparable to the similar devices based on Ir(ppy)$_3$ and FIrPic.

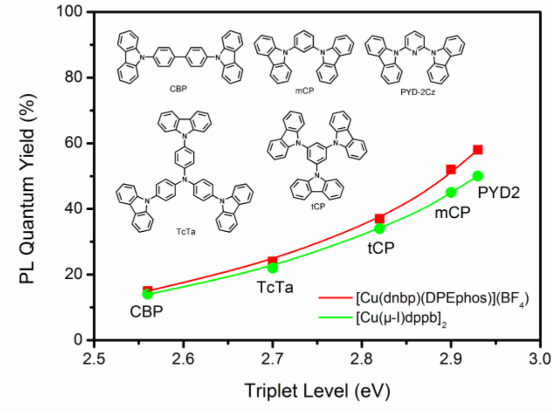

Fig. 1 PL quantum yield of 10wt% Cu^{I} complex doped in various host layers, CBP, TcTa, tCP, mCP and PYD2.

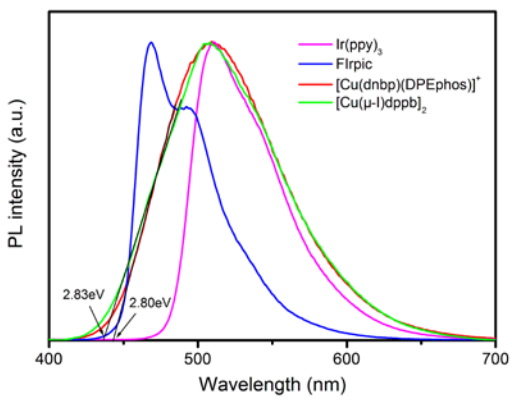

Fig. 2 PL spectra of 10wt% phosphorescent materials doped into a PMMA film.

[1] Q. Zhang et al., *Adv. Mater.*, **2004**, *16*, 432.
[2] Y. Kawamura et al., *Appl. Phys. Lett.*, **2005,** *86*, 071104.
[3] A. Tsuboyama et al., *Inorg. Chem*., **2007**, *46*, 1992.