Dependency of the emission efficiency on doping profile of the red phosphorescent organic light-emitting diodes

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Many researchers have been tried to improve the performance of the phosphorescent organic light-emitting diode(PHOLED) by controlling of the dopant profile in the emission layer.[1,2] In this work, as shown in Fig. 1 insert, a typical red PHOLED device which has the structure of ITO/NPB(50nm)/ CBP(30nm)/TPBi(10nm)/Alq_3 (20nm)/LiF(0.8nm)/ Al(100nm) is fabricated with a 5nm thick doping section in the emission layer. The doping section is formed by co-deposition of CBP and $Ir(btp)_2acac$ with a doping concentration of 8%, and it's location(x) is changed from HTL/EML interface to EML/HBL in 5nm steps.

The current efficiency versus current density of the devices are shown in Fig. 1. By changing the location of doping section, as shown in Fig. 1 and 2, at x=5nm, the efficiency shows the maximum of 3.1 cd/A at 0.5 mA/cm^2 and it is slightly decreased when the section is closed to HTL and slightly increased when the section is closed to HBL. If the doping section is closed to HTL(NPB) the excitons can be quenched easily to NPB's triplet state energy level(2.5eV) which is relatively lower than that of CBP(2.6eV). Because there is a hole accumulation at EML/HBL interface the efficiency can be increased slightly when the section is closed to HBL. Even the thickness of the doping section is only 5nm,. the maximum efficiency of 3.1 cd/A with x=5 is closed to that of the homogeneously doped device, 3.3 cd/A, because the diffusion length of the excitons is relatively long.[3]

As a result, we confirm that the current efficiency of the PHOLED can be improved by the doping profile optimization such as partially, not homogeneously, doped EML structure.

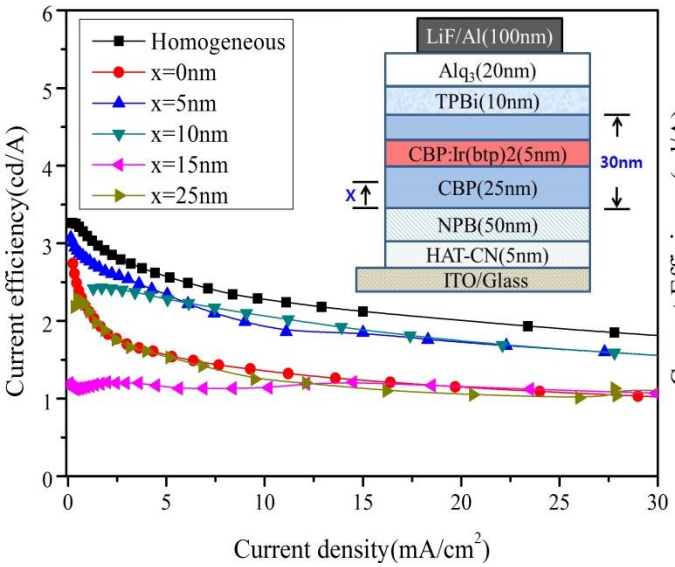

Fig. 1 Current efficiency changed by doping area from x=0 to 25nm and PHOLED devices structure

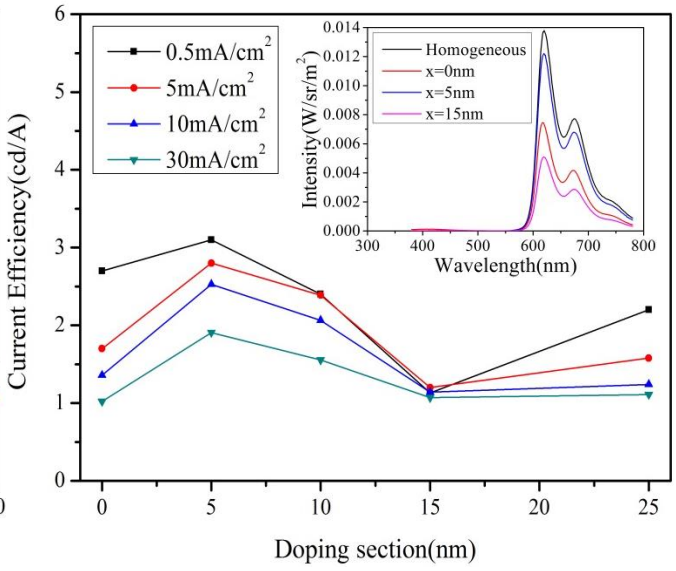

Fig. 2 Red efficiency changed by current density from 0.5 to 30 mA/cm^2 and red spectrum at 5mA/cm^2

References

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