Effect of Doping Profile on the Emission Mechanism and Efficiency of Green Phosphorescence Organic Light-Emitting Diodes

Wonhyeok Park, Kanghoon Kim, Jootae Park, Daechoon Kim, Ukrae Lee, and Sang Soo Kim
College of Information and Communication Eng., SungkyunkwanUniversity, Suwon, Gyeonggi-do, Korea
Tel.:82-31-290-7193, E-mail: sskim0703@skku.edu

In this work, PHOLED devices (insert of Fig. 1) which have the structure of ITO/HAT-CN(5nm)/NPB (50nm)/EML(30nm)/TPBi(10nm)/Alq_3(20nm)/LiF(0.8nm)/Al(100nm) with different locations of doping zone are fabricated to investigate the emission mechanism and efficiency of green PHOLEDs. The EMLs are formed by deposition of CBP with a 5nm thick $Ir(ppy)_3$(2% wt) doping zone. The distance from the HTL/EML interface to this doping zone(x) is changed from 0nm to 25nm in 5nm steps.

The electroluminescence characteristics and the external quantum efficiency(EQE) from the PHOLED devices with different locations of the green doping zone are shown in Fig. 2. The position of the doping layer was correlated with the light emission mechanism and device performance. In the CBP: $Ir(ppy)_3$ devices, the HOMO level of $Ir(ppy)_3$ is 5.3eV and the energy gap between CBP and $Ir(ppy)_3$ is 0.7eV. Therefore, the holes injected from HTL can be trapped to dopant sites directly if the dopant is closed to HTL, while electrons are injected from HBL easily and can be transferred to the host material due to the low energy gap between the host and the dopant. Therefore, the injection and transport characteristics of the hole are the major limit factors on emission efficiency.

As a result, the emission efficiency shows the maximum at x=25nm due to the accumulated holes by hole blocking layer(TPBi), and it decreases when doping zone is away from the HBL due to relatively lower accumulated hole density. The emission efficiency shows minimum at x=10nm because it is too far to trap holes directly from HTL. But, the efficiency is slightly increased again when the doping zone is closed to HTL due to increased direct injection and trapping of the hole from HTL.

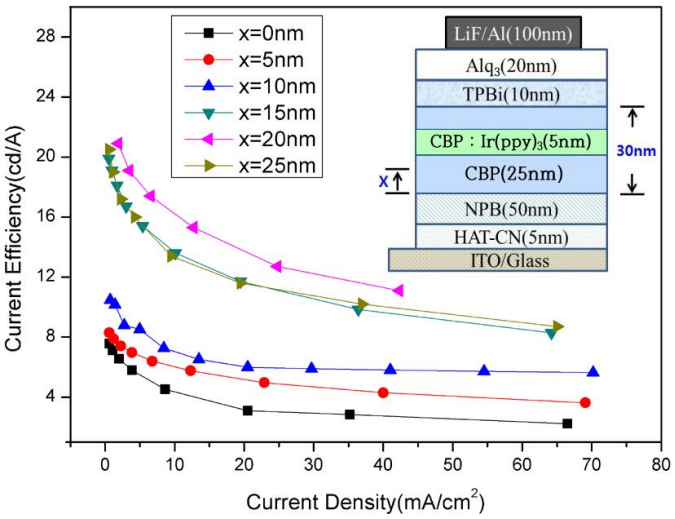

Fig. 1. Characteristics of PHOLED devices and its structure

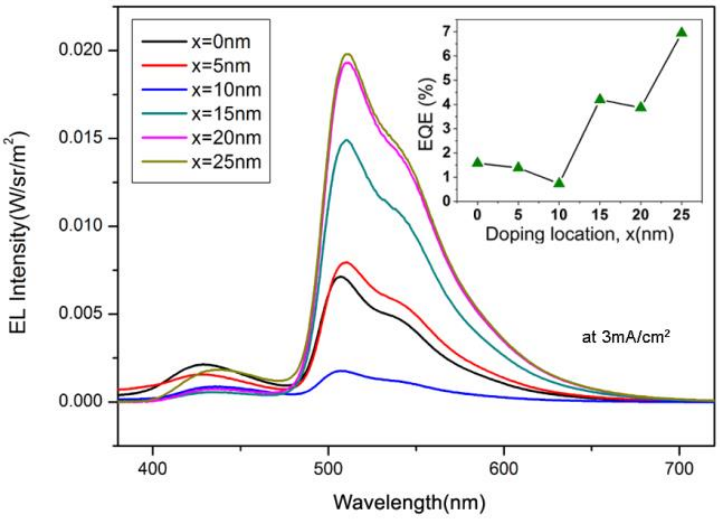

Fig. 2. EL characteristics and EQE of green emission with different doping locations

References

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