Diffusion Length Measurement of the Triplet Exciton in PHOLEDs by using Double Quantum Well Structure

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PHOLED devices which have the structure of ITO/HAT-CN(5nm)/NPB(50nm)/EML(47nm)/TPBi(10nm)/ Alq_3(20nm)/LiF(0.8nm)/Al(100nm) are fabricated to investigate the diffusion length of the triplet exciton by using double-quantum-well(DQE) EML structure. To fabricate DQW structures, $Ir(ppy)_3$(2% wt) and $Ir(btp)_2$(8% wt) are used as green and red emission zones, repectively. In DQW structured EML, as shown in Fig. 1, 1nm thick layers of geen and red emission zones are located middle of the EML, and the distance between these wells(x) is changed from 0nm to 10nm.

As shown in Fig. 2, the emission spectra from DQW PHOLED devices are changed with different x. The intensity of the green emission(520nm) is decreased when x is decreased, and it goes to near zero when x=0nm. This behavior can be identified as the diffusion of the triplet excitons from $Ir(ppy)_3$ to $Ir(btp)_2$ by the Dexter energy transfer(DET). From the external quantum efficiency(EQE) of the red emission, as shown in Fig. 3, the diffusion length of the triplet excitons can be determined by the equation of DET rate, $R=A\,Exp(-2R_{DA}/L)$, where R_{DA} is donor-acceptor distance and L is the sum of the van der Wals radii.

As a result, the measured data of the red EQEs with differnt x are identified to theoretical result from the equation of DET rate(Fig. 4). From this results, we could confirm that the diffusion length of the triplet excions can be determined by using DQW structure and this method is very useful to invertigate the behavior of the excitons in PHOLEDs.

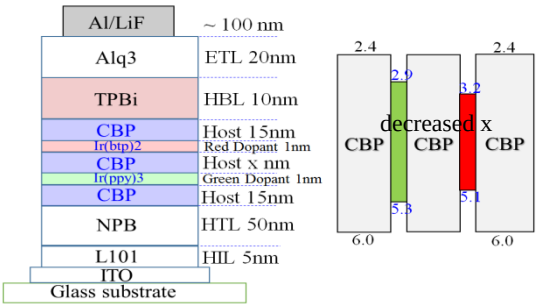

Fig. 1. DQW PHOLED device structure and Energy Diagram of DQW

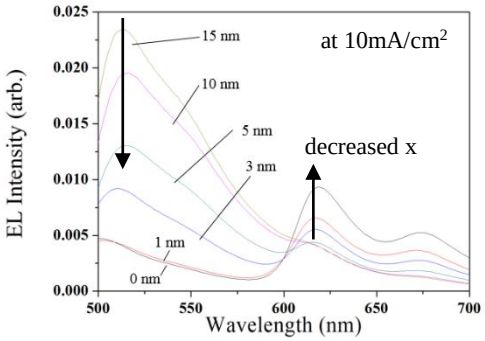

Fig. 2. EL characteristics of DQW PHOLED with different well distance(x)

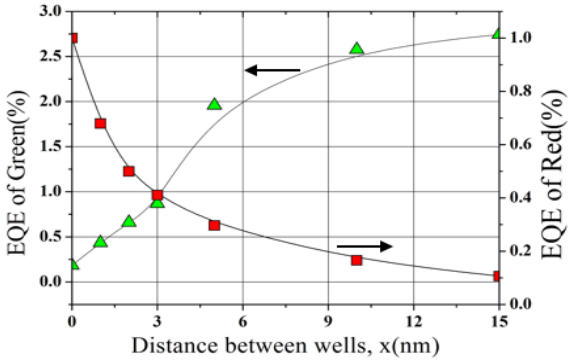

Fig. 3. EQE of red and green emissions versus well distance(x)

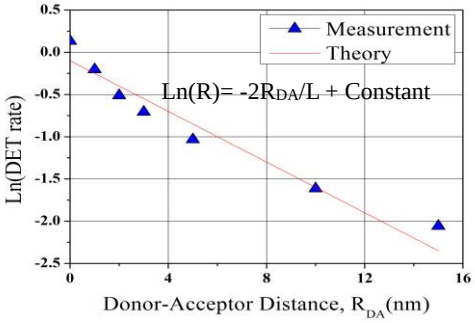

Fig. 4. DET rate versus donor-acceptor distance

References

1. M. Lebental, H. Choukri, S. Chenais, S. Forget, A. Siove, B. Geffroy, and E. Tutis, Physical Review B 79, 165318 (2009)