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Highly efficient exciplex organic light-emitting diodes incorporating a heptazine derivative as an electron acceptor

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1. Introduction

Thermally activated delayed fluorescence (TADF) molecules have attracted much more interest because almost 100% internal quantum efficiencies can be achieved. The crucial design strategy of TADF molecules is to possess a small energy gap (ΔE_{st}) between the lowest singlet and triplet excited states. Particularly, small ΔE_{st} can be readily realized by exciplex formation *via* intermolecular charge transfer between electron donors and acceptors.[1-2] In this study, a highly efficient exciplex system incorporating a heptazine derivative as an electron acceptor was developed.

2. Molecular design

The exciplex system contains a blended structure composed of 2,5,8-tris(4-fluoro-3-methylphenyl)-1,3,4,6,7,9,9b-heptaazaphenalene (HAP-3MF) as an electron acceptor, and 1,3-di(9H-carbazol-9-yl) benzene (mCP) as an electron donor. The molecular structures of mCP and HAP-3MF are depicted in Fig. 1. mCP is a widely used host molecule possessing two electron-donating carbazole moieties. HAP-3MF, which is composed of a heptazine core and three 2-fluorotoluene groups, was designed and synthesized as an electron acceptor.

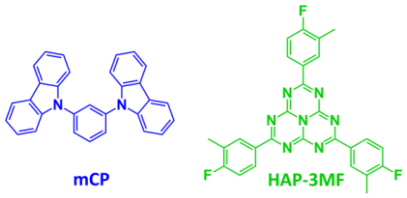

Fig. 1 Molecular structures of mCP and HAP-3MF.

3. Results

The UV-vis absorption and photoluminescence (PL) spectra of 8 wt% HAP-3MF:mCP blend film are depicted in Fig. 2a. This exciplex system exhibits a remarkably high PL quantum efficiency (PLQE) of 66.1%. Figure 2b shows transient PL characterisctics of this exciplex system. The transient decay curves in air and under vacuum conditions overlap well, suggesting that oxygen has almost no influence on the PL characteristics. Using the exciplex-based TADF characteristics, organic light-emitting diodes (OLEDs) containing

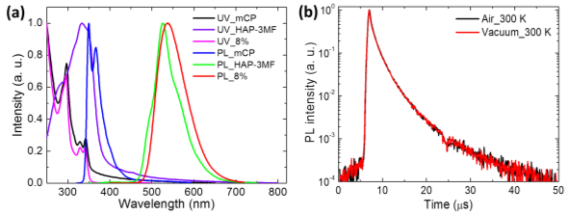

Fig. 2 (a) UV-vis absorption and PL spectra of mCP, HAP-3MF and 8 wt% HAP-3MF:mCP in solid films. (b) Transient PL decay characteristics.

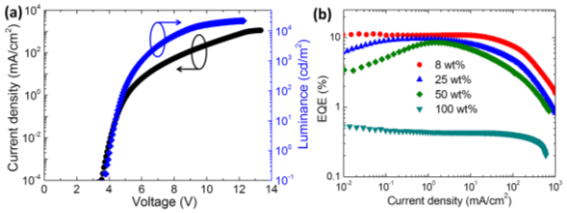

Fig. 3 (a) Current density-voltage-luminance characteristics. (b) EQE as a function of current density.

HAP-3MF:mCP with various weight ratios were fabricated. The OLED incorporating 8 wt% HAP-3MF:mCP showed the best performance with a rather high maximum external quantum efficiency (EQE) of 11.3% along with a low roll-off, and a quite high peak luminance of 22000 cd m^{-2} at 12.2 V (Fig. 3).

4. Conclusions

A highly efficient 8 wt% HAP-3MF:mCP exciplex system of with a high PLQE of 66.1% was developed. An OLED based on this exciplex system exhibits a rather high EQE of 11.3%.

Acknowledgements

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