Materials and Device Physics of Hyperfluorescence OLEDs and Future Prospect

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Abstract

Through the extensive R&D of organic light-emitting diodes (OLEDs) for more than 30 years, sophisticated novel organic optoelectronic materials and device architectures have been well developed, resulted in the unique commercial utilization of OLEDs for a wide variety of smartphones and large-area TVs. Particularly, the light-emitting materials in OLEDs are the central issue for realizing high electroluminescence (EL) quantum efficiency. Starting from the development of conventional fluorescence materials during 1990-2000th, room-temperature phosphorescence (2000-) and thermally activated delayed fluorescence (TADF) (2012-) continuously advanced not only OLED device performance but also photochemistry and photophysics. In recent days, OLED research has been focused on TADF because of the unlimited possibilities of TADF molecular design. Further, hyperfluorescence (HP)-OLEDs have been developed since they can realize the compatibility of high efficiency and narrow spectral width, which is a strong demand from practical display applications.

Here we report our recent cutting-edge HP-OLEDs demonstrating high OLED performance by optimizing host, TADF, and terminal emitter (TE) molecules[1-3]. In particular, we focus on the blue-emission, which is capable of showing narrow FWHM and high EL quantum yield. Blue HP-OLEDs based on two new TEs are fabricated, resulting in high external quantum efficiency (EQE), high color purity, and high brightness. By analyzing the transient EL spectra of the HP-OLEDs, we found that a smaller E_{HOMO} difference between TADF-assistant dopant (TADF-AD) and TE efficiently helps to decrease hole trapping inside the emitting layer, hence resulting in a lower efficiency rolloff and a longer operational device lifetime. HP-OLEDs based on a TE having the closest E_{HOMO} to that of TADF-AD show a maximum EQE of 22% together with a reduced efficiency rolloff (EQEs of 21.2% and 19.8% at 100 and 1000 cd m^{-2}, respectively). This report provides a designing principle for a TADF and TE molecules in HP-OLEDs with well-matched energy levels, leading to efficient FRET and no significant carrier trapping.

Further, we mention the future prospect of HP-OLED for the application of organic semiconductor lasers.

References

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