

Highly Efficient OLED Based on a Hidden Thermally Activated Delayed Fluorescence Channel in a Heptazine Derivative

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Considerable progress in organic light-emitting diodes (OLEDs) has triggered intensive effort to develop efficient solid-state electroluminescent (EL) materials over the past two decades. Among the many classes of materials being investigated, phosphorescent OLEDs containing transition metal complexes are highly attractive because they exhibit very high external quantum efficiencies (η_{ext}). However, transition metal-based compounds are rather expensive and unsustainable. Although fluorescent OLEDs have been assumed to show limited efficiency because of the branching ratio of singlet and triplet excitons of 1:3, the most recent researches have overcome this limitation using triplet-triplet annihilation and thermally activated delayed fluorescence (TADF). In particular, we have developed promising blue and green TADF materials.^[1-2] However, the design of efficient orange or red emitters is inherently difficult because the photoluminescence (PL) quantum efficiency tends to decrease as the emission wavelength increases according to the energy gap law.

In this study, we designed and synthesized an efficient orange-red TADF emitter, 4,4',4''-(1,3,3a1,4,6,7,9-heptaazaphenalene-2,5,8-triyl)tris(N,N-bis(4-(tert-butyl)phenyl)aniline) (HAP-3TPA).^[3] An orange-red OLED incorporating HAP-3TPA exhibits high EL performance with a maximum η_{ext} of $17.5 \pm 1.3\%$ and a peak luminance of $17000 \pm 1600 \text{ cd m}^{-2}$. Furthermore, although HAP-3TPA demonstrated weak TADF in the PL process, up-conversion from the lowest triplet state to lowest singlet state was quite efficient under electrical excitation, resulting in high EL efficiency.

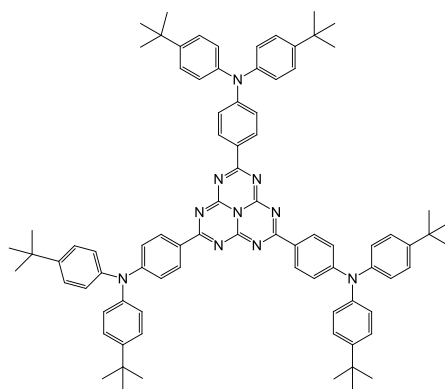


Figure 1. Molecular structure of HAP-3TPA.

References:

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