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Advanced Organic Luminescent Materials for Efficient Organic Light-Emitting Diodes

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In the past decades, organic light-emitting diodes (OLEDs) have been well commercialized due to the maturity of fluorescent (1^{st} generation) and phosphorescent (2^{nd} generation) emissive materials. However, both materials still are not perfect emitters for OLEDs. Recently, the 3^{rd} generation of organic light-emitting materials has been developed by combining the key advantages of the 1^{st} generation materials: simple structure and low cost and the 2^{nd} generation materials: capable of up to 100% intrinsic quantum efficiency (IQE) due to its emission from both singlet and triplet excitons. The 3^{rd} generation emissive materials still retain the basic structure of the 1^{st} generation organic molecule, but they are structurally modified at the molecular level to harvest additional light emissions from triplet excitons, giving rise to high IQE, simple molecular structure, and low-cost emissive material. In this talk, I will focus on our recent developments in 3^{rd} generation of organic luminescent materials capable of producing high IQE *via* several mechanisms, including thermally activated delayed fluorescence (TADF), hybridized local and charge-transfer excited state (HLCT), triplet-triplet annihilation (TTA), excited-state intramolecular proton transfer (ESIPT) and aggregation-induced emission (AIE) for high-performance organic light-emitting diodes (OLEDs). Our latest achievement in developing and utilizing fluorescence metal-organic framework (MOF) as advanced luminescent materials for OLEDs will be discussed. Finally, the study and development of novel solution-processable luminescent materials in which the essential elemental functions of an OLED, namely an intense solid-state light emission, electron/hole injection and transport capabilities, and solution-processability, would be incorporated by design into a single molecular architecture, will be illustrated. Some examples of solution-processable emissive materials will be discussed in terms of the structure-property relationships, with particular attention to the molecular design that affects the OLED device performance.

Keywords: organic luminescent materials, organic light-emitting diodes (OLED), thermally-activated delayed fluorescence (TADF), hybridized local and charge-transfer excited state (HLCT), triplet–triplet annihilation (TTA), solution-processable luminescent materials, fluorescence metal-organic framework (MOF)

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