

Recent progress in TADF OLED materials and organic hyperbolic materials

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Abstract:

The first part of my talk will be devoted to curcuminoid boron difluoride (CurcuBF₂)¹ and dibenzoylmethane boron difluoride (dbmBF₂)² derivatives, which have emerged as two promising families of OLED emitters. Previous studies have reported a donor–acceptor–donor (D–A–D) CurcuBF₂ achieving 10% EQE in NIR thermally-activated delayed fluorescent (TADF) OLEDs³ and a dbmBF₂ derivative displaying a wide range of OLED emission colors by controlling monomer, excimer and exciplex emissions.⁴ Here, I discuss the influence of the acceptor and donor strengths on the photophysical properties of D-A-D CurcuBF₂ emitters.^{5–7} In particular, moderately donating groups were found to promote the charge-transfer character of the singlet excited-state enabling efficient TADF, whereas stronger donors increased polymethine character, favoring local excited emission and suppressing TADF. The establishment of this structure-property relationship provides essential guidelines for the rational development of CurcuBF₂ emitters and their use in next generation NIR OLED applications. I will then present a recent photophysical study showing the influence of the host material on the photophysical properties of dbmBF₂ derivatives. The role of their triplet excited state energy, polarity and HOMO level is discussed as they play an essential role in the formation of exciplexes in these materials and their reverse intersystem crossing. Using two different host materials with the same dbmBF₂ emitter, we demonstrate a blue OLED with a maximum EQE of 4% and showing room temperature phosphorescence, and an efficient green exciplex TADF OLED with a maximum EQE of 21%. This study provides important insights into the mechanism of dbmBF₂ – exciplex TADF and should be taken into account in their future development for OLED applications.

Independently of OLEDs and organic optoelectronics research, hyperbolic metamaterials, typically based on metal/dielectric multilayers or nanowire composites, have attracted considerable interest because their strongly anisotropic permittivity leads to unusual optical properties such as negative refraction, large photonic density of states, and enhanced light–matter interactions.⁸ Alongside these engineered artificial plasmonic systems, attention has recently turned to naturally-occurring materials that can display hyperbolic dispersion without complex nanofabrication, including organic materials. In the second part of my talk, I will discuss the optical properties of several organic thin films showing hyperbolic dispersion and will present some recent results obtained in a squaraine derivative.^{9–11} Neat films of this new compound show a strong H-aggregation and a hyperbolic dispersion in the visible spectral range. I will then discuss some optical simulation results showing the possible effects of organic hyperbolic film nanostructuring on their optical properties and the photophysical properties of a light-emitting dyes located in their vicinity.

References

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