Boron Difluoride Complexes: Powering the Next Generation of Luminescent Organic Electronics

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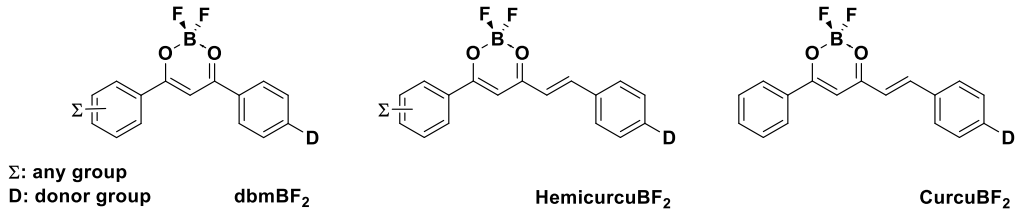
Boron difluoride complexes incorporating an acetylacetone core constitute a particularly attractive molecular platform due to the strong electron-withdrawing character of the BF_2-chelated β-diketone unit. This feature, combined with its rigid and planar structure, promotes efficient π-conjugation and enhances photophysical stability compared to phenol-like backbone. By introducing electron-donating groups at the periphery of this backbone, it is possible to construct a wide range of donor–acceptor (*i.e.* D–A)[1] and donor–π–acceptor or donor–π–donor (D–π–A or D–π–D)[2,3] architectures. Fine tuning of the electronic coupling between the donor fragments and the central acceptor enables precise modulation of absorption and emission properties, leading to luminescent materials that span the entire visible spectrum and extend into the near-infrared (NIR) region.

In this presentation, I will first describe the different molecular families that can be prepared from this versatile scaffold, highlighting synthetic strategies and structure–property relationships. Particular emphasis will be placed on how conjugation length, donor strength, and molecular symmetry govern the photophysical properties of the systems, including emission maxima, fluorescence quantum yields, and solvatochromic behavior. In addition, the nature of the excited states will be discussed to determine whether the emission arises from a locally excited state or an intramolecular charge transfer state.



Scheme 1. Different families of BF_2-chelated β-diketone unit discussed herein.

For example, derivatives based on curcuminoid– BF_2 and dibenzoylmethane– BF_2 frameworks have demonstrated strong potential as emissive materials in organic light-emitting diodes (OLEDs), exhibiting high external quantum efficiencies (EQE), a key parameter used to evaluate OLED performance. Their high fluorescence quantum yields, good thermal stability, and tunable energy levels make them suitable for solution-processed-deposited devices. Moreover, (hemi-)curcuminoid boron difluoride derivatives have shown promising amplified spontaneous emission (ASE) properties, highlighting their potential as active materials for organic lasers and photonic applications.

Overall, BF_2-chelated β-diketone systems represent a highly adaptable platform for the design of advanced optoelectronic materials, bridging fundamental photophysical studies and practical device integration allowing powering the next generation of luminescent organic electronics.

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[2]: D.-H. Kim, A. D'Aléo, X.-K. Chen, A.S.D. Sandanayaka, D. Yao, L. Zhao, T. Komino, E. Zaborova, G. Canard, Y. Tsuchiya, E.Y. Choi, J.W. Wu, F. Fages, J.-L. Brédas, J.-C. Ribierre and C. Adachi *Nat. Photon.* **2018**, *12*, 98-104.
[3]: A. D'Aléo, X. Tang, D. H. Kim, D. Valverde, E. Zaborova, G. Canard, A. Brosseau, L. Mager, G. Clavier, C. Adachi, Y. Olivier, J.-C. Ribierre, *Adv. Opt. Mater.* **2025**, *13*, 20, 2500338.