Ambient Phosphorescence from Arylene Mono and Diimides

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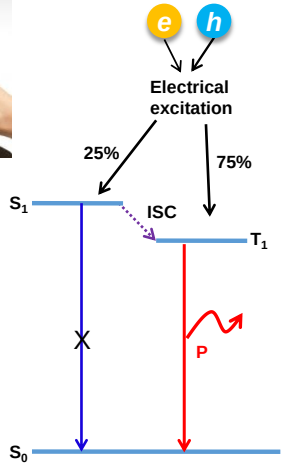
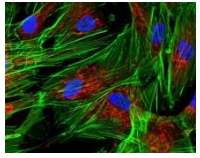
Introduction and Design Strategy

Displays



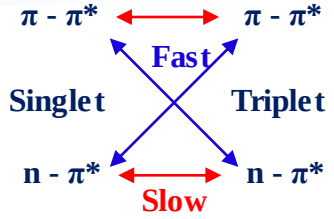
OLEDs



Bio-imaging

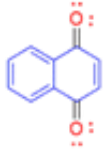
Requirements :-

- High intersystem crossing rate
- High spin-orbit coupling between the singlet and triplet excited state .

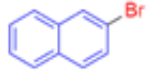


Rate of ISC increases when there is a change in the molecular orbital configuration

Follows El-Sayed's Rule

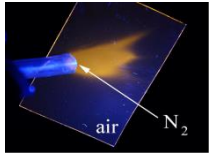


Heavy-atom Effect



Strong SOC

- Traditionally, organic phosphorescence has been studied in cryogenic temperatures and inert atmosphere.
- Triplets are easily quenched by molecular oxygen and vibrational dissipation.



Optical Sensing

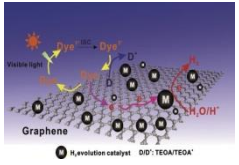
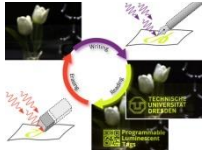
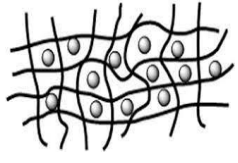


Photo-catalysis

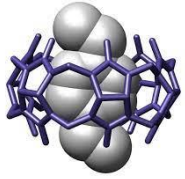


Data Security

Crystallization



Polymer Matrix



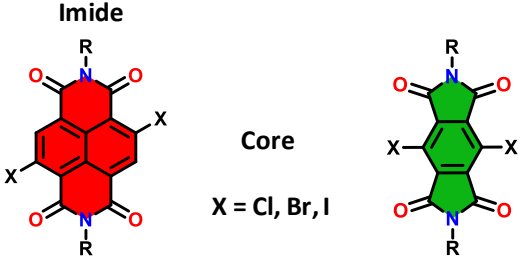
Host-guest

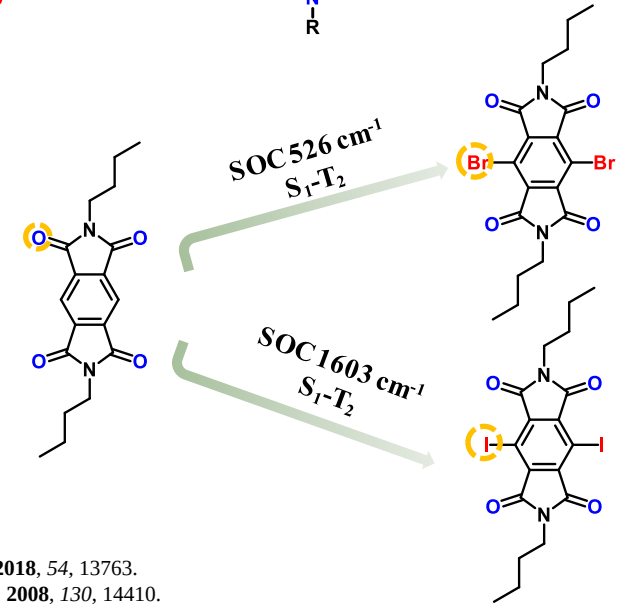
App. Phys. Lett., **1987**, *51*, 913; *Nature* **1990**, *347*, 539; *Nature* **1998**, *395*, 151; M. El-Sayed, *J. Chem. Phys.* **1963**, *38*, 2834.

Why Arylenediimides?

Arylene diimides have been extensively investigated for various optoelectronic applications as electron-deficient semiconductors

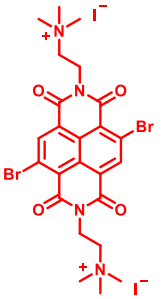
- **Core-substitution with heavy atoms to increase the SOC**
- **Multiple carbonyl groups in the backbone can increase ISC efficiency**

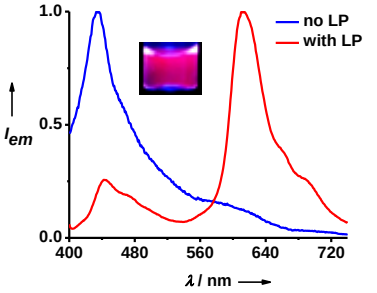


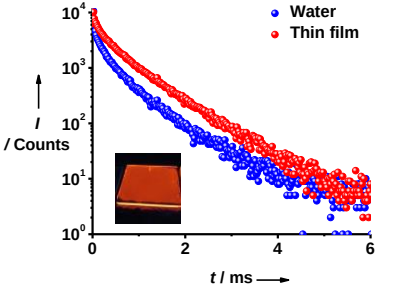


Chem. Commun. **2018**, *54*, 13763.
J. Am. Chem. Soc. **2008**, *130*, 14410.

Naphthalenediimide

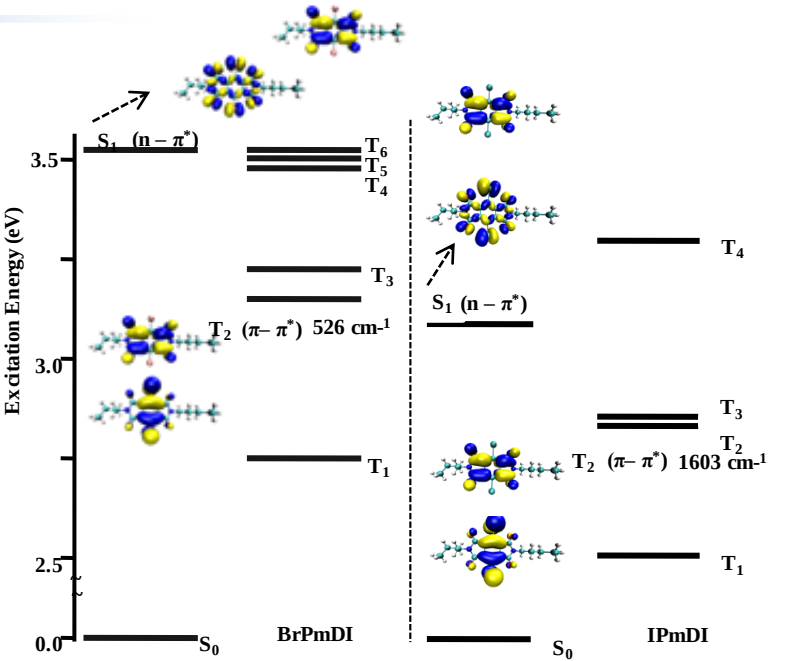




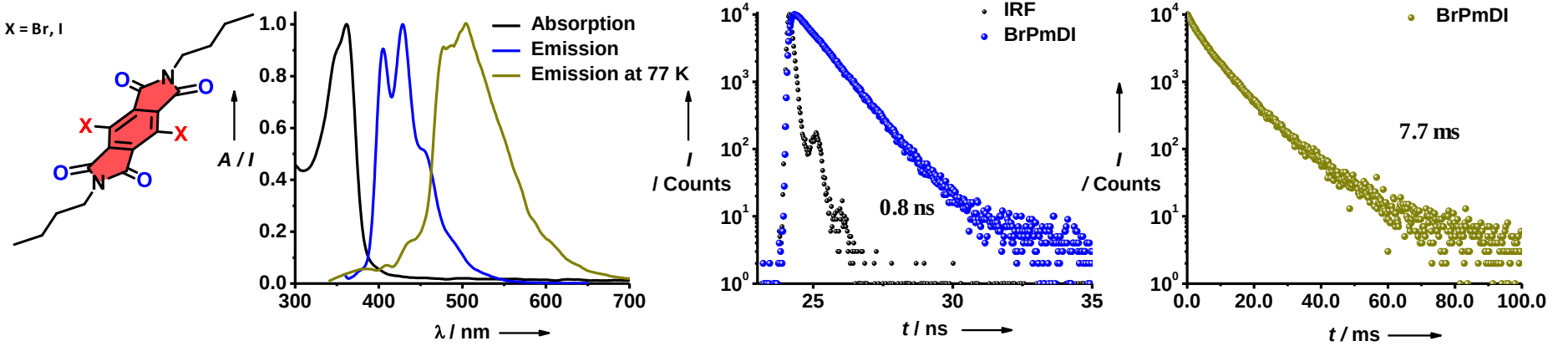


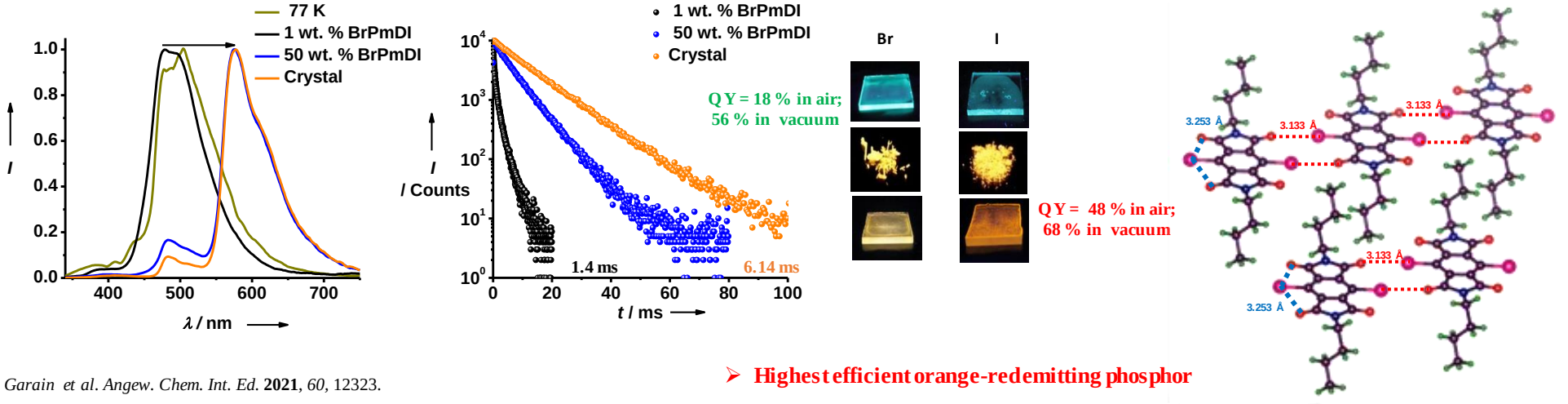
Kuila et al. Angew. Chem. Int. Ed. **2018**, *57*, 17115.

Pyromelliticdiimides



Twin Phosphorescence of Pyromelliticdiimides

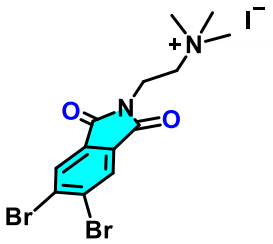


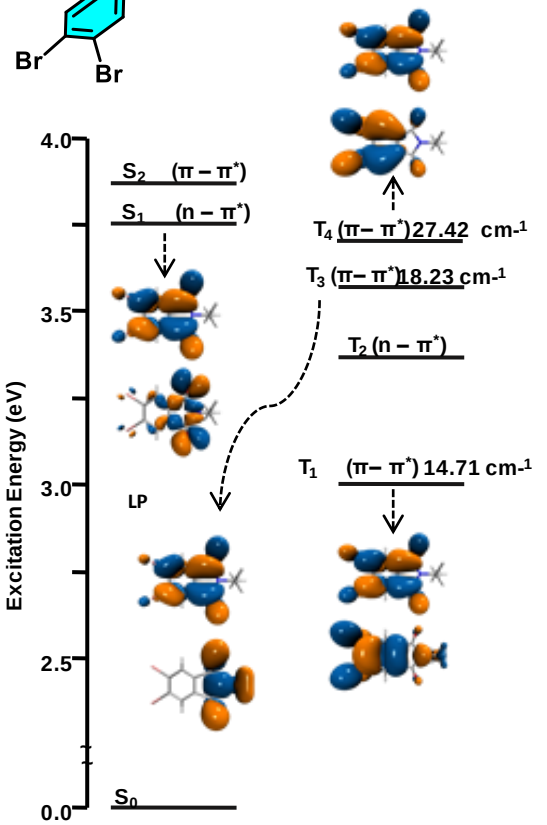


➢ **Highest efficient orange-red emitting phosphor**

Garain et al. Angew. Chem. Int. Ed. **2021**, *60*, 12323.

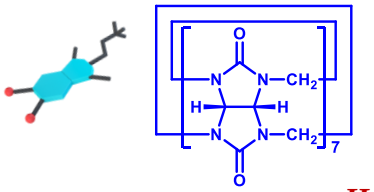
Phosphorescence in Water





➢ **Highest efficient solution state phosphor**

Garain et al. Angew. Chem. Int. Ed. **2021**, *60*, 19720.



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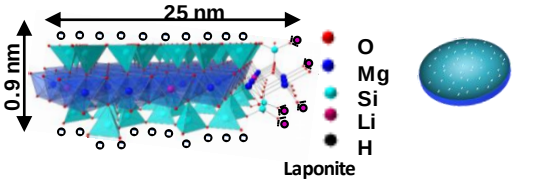
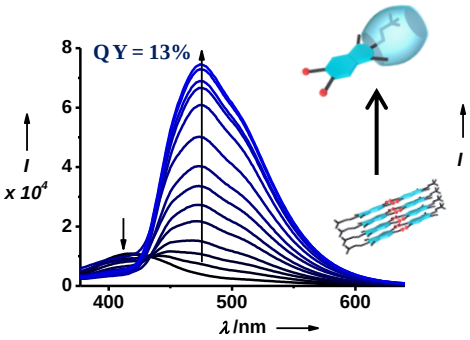
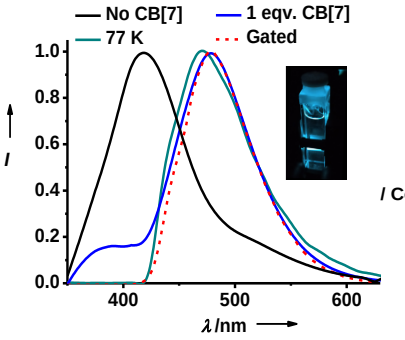
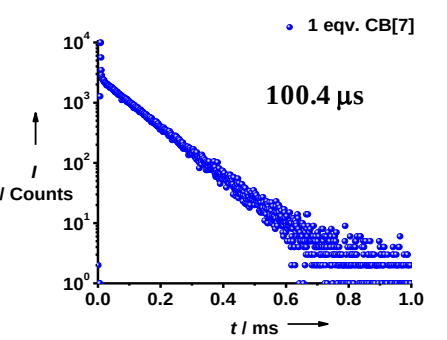


Laponite

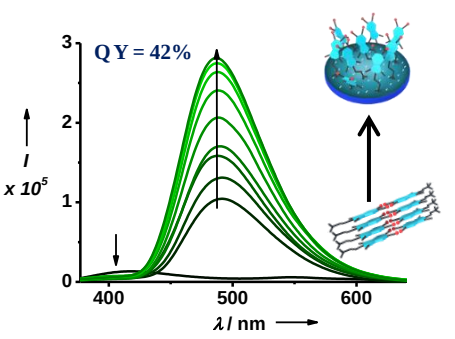
Host-guest Strategy

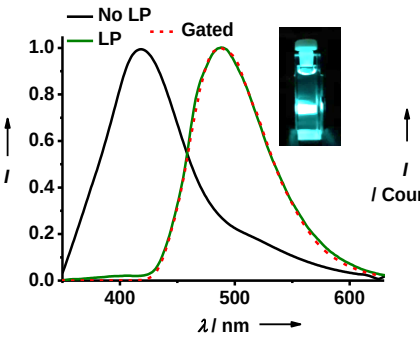


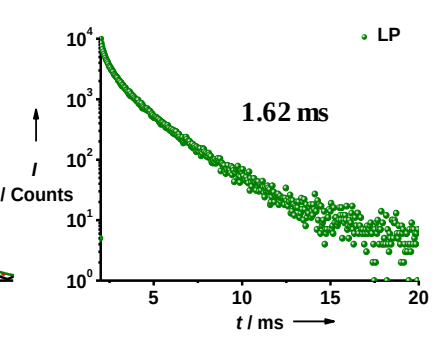




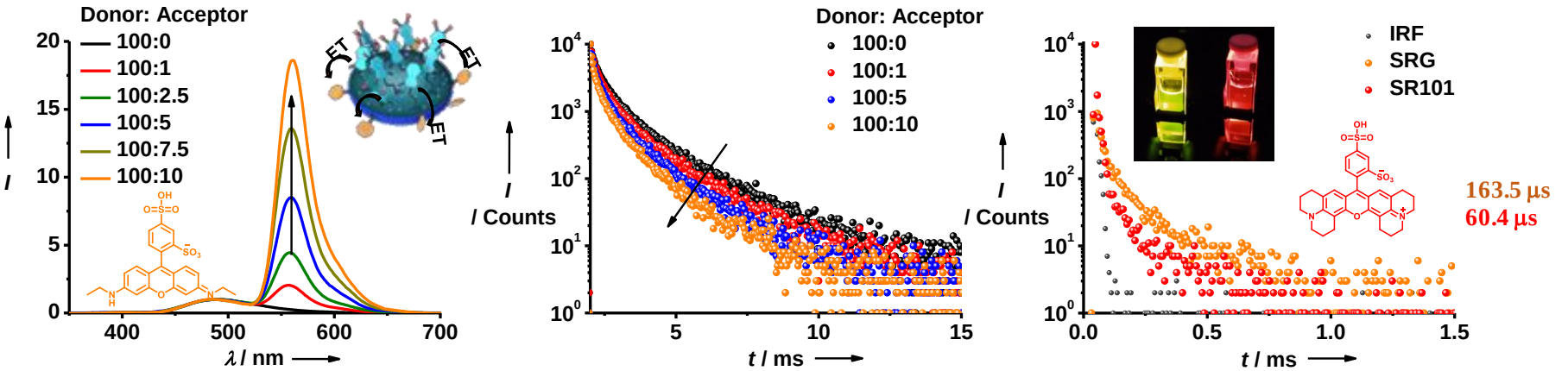
Supramolecular Scaffolding Approach







Phosphorescence FRET in Water



Conclusion

- We have introduced a new class of small organic molecule based efficient, ambient organic phosphors from the smallest member of arylene mono and diimide family, by a rational "heavy-atom" substitution strategy.
- The derivatives reported here showed high phosphorescence quantum yield (~48 % and ~68 %, in air and vacuum, respectively) with exceptional air stability.
- Highest phosphorescence quantum efficiency in solution (41.8 %) is achieved.
- Triplet-to-singlet energy transfer mediated delayed fluorescence is achieved from fluorescence emitter.

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Thank You