Luminescent organics: from isolated molecules to organized solids

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Molecules and materials with the ability to emit light are a critical part of both fundamental science and everyday life, with applications ranging from fluorescent biological probes to sensors to lightning devices. Recently, all-organic luminescent molecules have emerged as a promising alternative to inorganic materials, avoiding the use of toxic or expensive metals, while being easily modified in order to tune their properties, particularly the emitted light color. One of the current limitations of all-organic chromophores is the loss of efficiency in concentrated solutions or in the solid state, because the interactions between the fluorophore molecules usually form non-emissive species. However, careful design of the chromophores avoids the interactions leading to emission loss, promoting the organization of the molecules into emissive solids.

We developed new all-organic molecules exhibiting different luminescent properties in solution and in the solid state. Although a family of diarylmethane derivatives (Fig. 1) is non-emissive in solution they become highly luminescent upon crystallization. This behavior was rationalized by their crystal structure, which shows that the molecules self-assemble into chains linked through hydrogen bonds, efficiently rigidifying the structure.

A series of prepared boron diketonate complexes exhibit fair luminescent properties in dilute solutions, emitting in the yellow range of the visible spectrum. When the concentration increases, the emission color disappears and is replaced by a red color (Fig. 2) attributed to the formation of dimeric species, as confirmed by the crystal structures of the compounds.

These approaches pave the way toward all-organic luminescent materials based on small molecules, which could then be used for biological imaging or in solid emitting devices.

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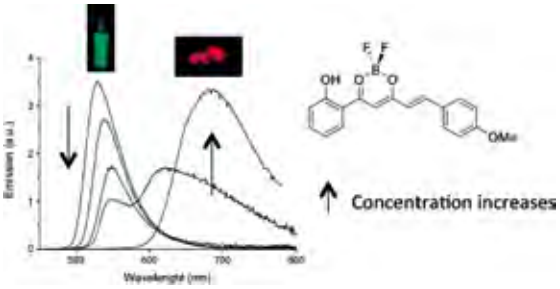

FIGURE 1
Exemple of a fluorophores with excimer formation in the solid state. The yellow luminescence observed in dilute solution disappears when the concentration increases, replaced by the red luminescence of the excimer.

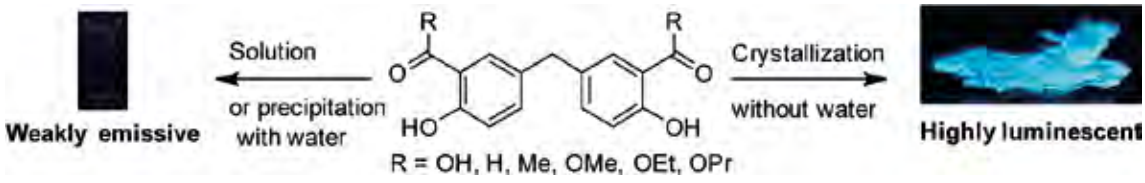

FIGURE 2
Compounds with crystallization-induced emission enhancement properties.