Photoactive Nanomaterials based on Zeolite L doped with BODIPY

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The incorporation of organic photoactive molecules into nanostructured solid host is an active area of research.[1] Such materials offer many advantages for the development of new versatile optoelectronic devices. On one hand, the rigid environment of the solid host protects the organic molecule against chemical or photochemical attacks and increases its thermal resistance. Moreover, such constrained framework can modulate the electronic and optical properties of the organic guest. On the other hand, the organic molecule can act as a fluorescent sensor to monitor the physicochemical characteristics of the surrounding solid environment of the fluorophore.

To this aim laser dyes are adequate guest molecules. Among the different laser dye families covering the ultraviolet and visible region, recently Boron DiPyrromethene (BODIPY) fluorophores are becoming one of the most used molecules in tunable lasers, fluorescent sensors, antenna systems or fluorescent markers in biochemical systems (Figure 1).[2] This is due to their unique photophyscial properties. BODIPY laser dyes present strong absorption and fluorescence bands characterized by very high fluorescence quantum yields. Besides, the emission region and even their photophysical properties can be modulated by the adequate substitution pattern. Taking all these features into account we decide to incorporate this fluorophore into a nanostructured host with a channel architecture. In this sense zeolite L fulfill of these requirements.[3] Zeolite L is an aluminosillicated with one-dimensional channels running along the crystal with a pore diameter of about 7.1 Å (Fig. 1). Both commercial zeolite L (Lucidot) and ourself synthesized zeolite L by the hydrothermal method assisted by microwave energy, have been employed.

Therefore, the present work is focused on the incorporation of BODIPY dyes into the nanochannels of zeolite L and the spectroscopic and microscopic characterization of the resulting material. The dye doped zeolite has been successfully achieved by gas adsorption at high temperatures after sublimation at vacuum of the BODIPY. Thus, a highly fluorescence material is obtained since the BODIPY is adsorbed into the pores exclusively in the monomeric form. The photophysical properties of the dye doped zeolyte remind to those recorded in diluted dye solutions in spite of the high number and proximity of the dye molecules in the channels. In this way, the presence of aggregates is avoided, which damage the fluorescent ability of the dye. Polarized light confocal microscopy ensures that the BODIPY is only present in the inner space and not in the outer surface of the zeolite. Moreover, the anisotropy response of the material indicates that the geometrical restrictions of the channels orient the dye with its transition moment parallel to the main axis of the channel (Figure 2).

Summing up, we have obtained zeolite L crystals doped with a high amount of BODIPY dye without sign of aggregation. Consequently, a highly fluorescent and ordered material is obtained. Moreover, the cage-protecting effect of the zeolite improves the thermostability of the dye. Such requirements are essential in order to be successfully applied in optolectronic devices. Further work is in progress in our laboratory to explore the possibilities of these novel hybrid materials.

References

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Figures

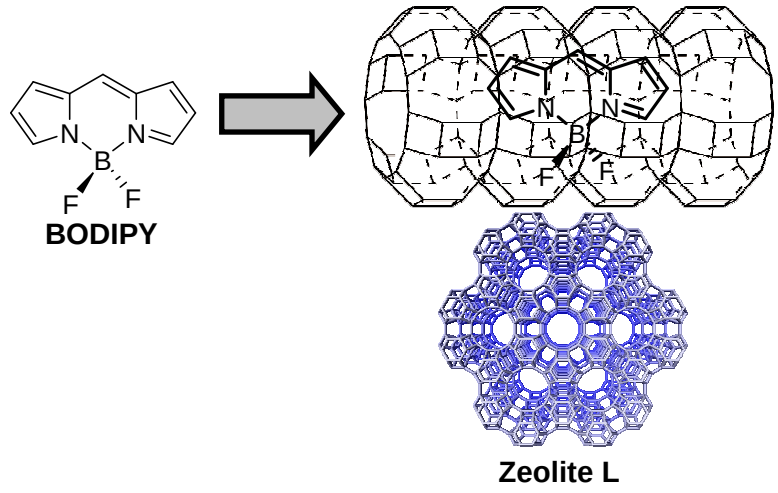

***Figure 1**. Boron DiPyrromethene (BODIPY) molecular structure and view of the channel framework of zeolite L.*

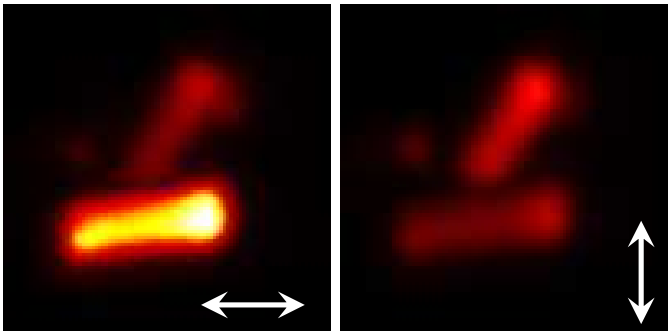

***Figure 2.** Fluorescence confocal microscope images of micrometer-size zeolite L doped with BODIPY with horizontal and vertical polarized light.*