Mesoporous oxides as nano-reactors for building luminescent nanostructures

Diego A. Onna, María Luz Martínez-Ricci, Gastón Siano, Sara A. Bilmes

Instituto de Química Física de los Materiales, Medio Ambiente y Energía (INQUIMAE)and Departamento de Química Inorgánica, Analítica y Química-Física (DQIAQF), Facultad de Ciencias Exactas y Naturales - Universidad de Buenos Aires

*e-mail: sarabil@qi.fcen.uba.ar

Luminescent materials are envisaged for different applications, such as lasers, bio-labels and solar cells. However, most of them are toxic for humans and involve the use of low-abundance elements with costly and environmental non-friendly mining.

Nanomaterials offer a new path towards luminescent devices and bio-labels with low mass content. Moreover, these devices present the possibility of tunning the semiconductor luminescent emission as size gets near the Bohr exciton. Nevertheless, new problems arise considering that the high area to volume ratio enables a high fraction of excited atoms lie at the surface, which may interact with the surrounding medium and induce quantum efficiency diminishing. In addition, nanoparticles are believed to be intrinsically harmful as they can cross the cell wall disrupting metabolic processes and DNA replication.

As a possible solution for these problems, we propose the use of nanostructures made of reproducible ordered mesoporous SiO_2 films containing luminescent nanoparticles as building blocks for more complex composite structures. The advantage of this approach is the reduced amount of heavy metals involved, as well as providing fixed nanoparticles in an inert matrix. The main idea is to obtain an efficient luminescent material controlling its size with that of the matrix pore, and to regulate the emission intensity through interactions with the pore wall.

Using each pore as a single nano-reactor, an environmentally friendly synthesis was carried out by successive immersions in solutions of the appropriate precursors. Special attention is paid to solvent and precursors role in the growth mechanism inside pores leading to optimized photoluminescence. This approach was successfully carried out for obtaining semiconductor CdS Q-dots and YVO_4:X (X= Eu; Yb:Er; Yb:Ho) nanophosphors embedded in a silica matrix with intense luminescence even for very low mass amounts.