Novel Nanocomposites Based on Silica via Reverse Microemulsions and Lanthanide-Based Coordination Polymers

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Among the arising nanotechnologies in catalysis, optical or biological, multifunctional nanoparticles with complex architecture constitute one of the most promising and studied research fields.In our work, the control of the luminescence property of nanomaterials is mandatory for applications in photonic and biomedical areas. By exploiting important colloidal phenomena, the goal of our work is to synthesize new luminescent and stable nanomaterials.

This contribution highlights our efforts to elaborate and to characterize various colloidal nanostructures based on different luminophors such as: lanthanide coordination polymers or γ-Fe_2O_3-Mo_6X_{14}@SiO_2 or γ-Fe_2O_3-Mo_6X_{14}@SiO_2@Au.

In the first part, we will summarize our results on the synthesis and characterization of luminescent Mo_6X_{14}@SiO_2 colloidal solution. Such nanoparticles including Mo_6X_{14} metal atom clusters (MC) as phosphors are good candidate for photonic crystal or bioimaging knowing that the red/infrared Mo_6 emission range could be selectively transmitted through tissues due to the low absorption at these wavelengths. Moreover, they generate singlet oxygen under irradiation, what is of particular interest for photodynamic therapy. In addition, we will show the possibility to encapsulate γ-Fe_2O_3 and luminescent molybdenum clusters units in silica nanoparticles through a W/O microemulsion process and the evolution of the luminescence properties as a function of the size of the magnetic core.
To our γ-Fe_2O_3-Mo_6X_{14}@SiO_2 MPs, small gold nanoparticles can be deposited on the surface of silica NPs allowing the preparation of gold nanoshells. Thus, thanks to the strong absorption of the plasmon band in the visible region, gold NPs can convert the absorbed light into heat, allowing the local destruction of cancer cells.

In the second part, we will show the possibility to stabilize solutions of polymer coordination nanoparticles by solvation in a green chemistry solvent. For more than a decade, lanthanide-based coordination polymers have attracted great attention, because of their topologies coupled with their great potential applications in luminescence and molecular magnetism. These solutions exhibit intense luminescence using very little quantities of heteronuclear lanthanide terephtalate coordination polymers and are stable over time: no particle aggregation or decrease in luminance is observed.

The real challenge was to synthetize a non-toxic solution that combines the luminescence of the clusters in the NIR and lanthanide-based coordination polymers so it would be useful in several fields such as: nanomedicine, magnetic resonance imaging, fluorescence microscopy and to create luminescent surfaces.