

## Spectroscopic Studies of Energy Transfer between Semiconductor Nanoparticles and $\text{Eu}^{3+}$ Ions in Silica Gels

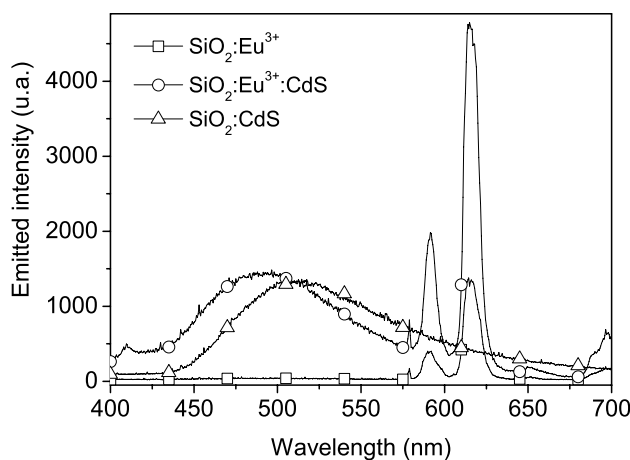
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Porous silica-based materials receive widespread attention with much current interest focused on the optical properties of nanoporous sol-gel silica glasses and the potential development of such glasses for photonic applications. The doping of these systems with rare earth ions (RE) or semiconductor nanoparticles (NP) can lead to the development of improved optical amplifiers or displays. The sol-gel technique presents advantages for the preparation of nanoporous vitreous oxides, allowing the control of the transparency and of the nanoporous structure of the derived materials. Adjustment of the composition and of the heat-treatment of the gels can be used to control their porous structure (which can be followed using Raman spectroscopy), thus permitting post-doping with various species like active ions and NP. The pores of the host matrix can also control the NP size, an important factor since the optical properties of semiconductor NPs result from the size-dependant quantum confinement effects of NP clusters.

In the present work, silica xerogels were synthesized using base-catalysis. After a heat treatment at 850°C, the resulting gels were post-doped with NP precursors. Raman and photoluminescence spectroscopic data were correlated with nitrogen adsorption-desorption measurements. With gel pore sizes ranging from 30 to 100 Å, the NP size varied from 25 to 40 Å. Raman spectral changes indicated the structural evolutions responsible for the pore-size changes and the increasing NP size resulted in a red-shift of the NP emission band.

Co-doping  $\text{SiO}_2$  gels with semiconductor CdS NPs and  $\text{Eu}^{3+}$  RE ions can lead to efficient energy transfer from the NPs to the RE ions and a resulting increased RE emission. The changes in gel structure resulting from variations in concentration of doping agents as well as from different heat treatments have distinct effects on the RE emission. The energy-transfer presented in Fig.1, between NC and RE ions, was studied using excitation and emission photoluminescence spectroscopies.



**Fig. 1:** Luminescence spectra of a 1%  $\text{Eu}^{3+}$ -1% CdS codoped gel and a 1%  $\text{Eu}^{3+}$ -doped gel treated at 200 °C ( $\lambda_{\text{ex}}=351.1$  nm)