Use of Spectroscopic Techniques for Synthesis Optimisation and for the Characterisation of Optical Properties of Semiconductor Nanoparticles

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Semiconductor nanocrystals (NCs) are studied because of their unique physical properties which are very different from those of their corresponding bulk materials and lead to strong confinement of the charge carriers and phonons and as a result, the band-gap of such materials can be tuned from the near infrared to the visible simply by changing the NC size, thus making them promising "building blocks" for a wide number of applications in photonics, biophotonics and optoelectronics.

In the first part of the present work, PbSe NCs were synthesized using a colloidal route. The resulting NCs with a narrow size distribution were characterized using TEM, absorption spectroscopic measurements as well as with micro-Raman spectroscopy. The Raman spectrum of Figure 1 shows the first-order longitudinal optical phonon and its first overtone for a NC sample, thus confirming the existence of PbSe. TEM images of the same sample showed quasi-spherical PbSe NCs of about 7 nm. The size-dependence of the position of the two Raman bands has been established and a correlation with TEM data will be presented.

In the second part, semiconductor nanocrystals of SnO_2 were used to transfer energy to rare-earth (RE) ions. In effect, if RE ions are doped into semiconductor nanoclusters with their crystal-like arrangement, then band gap excitation may result in efficient energy transfer thus yielding intense luminescence from the RE ion. In the present work, europium doped tin silicate thin-film samples were fabricated via sol-gel syntheses using the dip-coating technique. Spectroscopic investigations are carried out using mainly Raman and x-ray. Figure 2 shows the Raman spectra collected in the waveguiding configuration for samples heat-treated in air at temperatures ranging from 800 to 1100 °C. The formation and growth of nanocrystals with increasing temperature is evident from the shifts observed in the sharp crystal peak in the low frequency region. Raman data has been used to determine the size and structure of the nanocrystals.

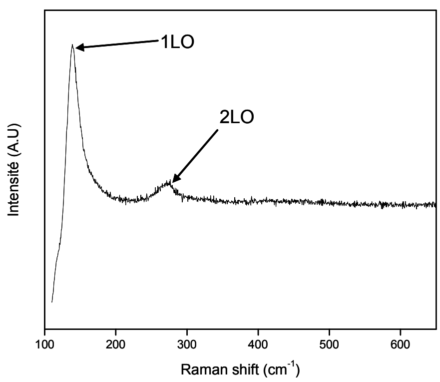

Figure 1: Raman spectrum of 7-nm PbSe NCs

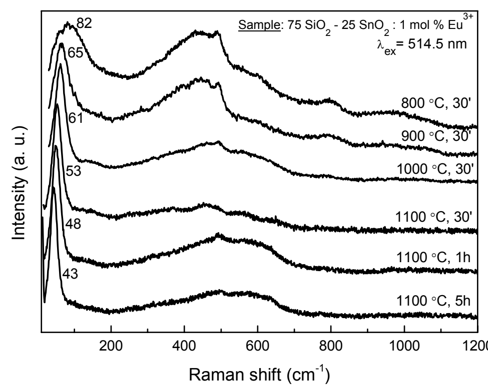

Figure 2: Raman spectra of samples as a function of annealing temperature and time.