Photoluminescence, Thermoluminescence and Energy Transfer Process in Sm^{3+}:ZrO_2 Nanocrystals

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Abstract
The photoluminescence, thermoluminescence and crystalline structure characterization of undoped and several samarium doped ZrO_2 samples are reported. Strong fluorescence emission produced by the transitions $^4G_{5/2}\rightarrow{}^6H_{5/2,7/2,9/2}$ of Sm^{3+} was obtained by the excitation of the host at 320 nm. The energy transfer process from the host to the samarium ion was confirmed by the analysis of the ZrO_2 fluorescence decay curve. It is shown that the content of the active ions stabilizes the tetragonal structure of ZrO_2 at 1000°C, being 73% for 2mol% Sm_2O_3 doped and 3% for undoped samples. The dependence between the fluorescence emission and the crystalline structure is discussed. Beside the interesting results here presented, the excellent chemical and photochemical stability of nanocrystalline zirconium oxide as well as its low phonon energy suggest a large potential for a number of application such as active optical windows, new generation television screen, dosimeter and lighting source.

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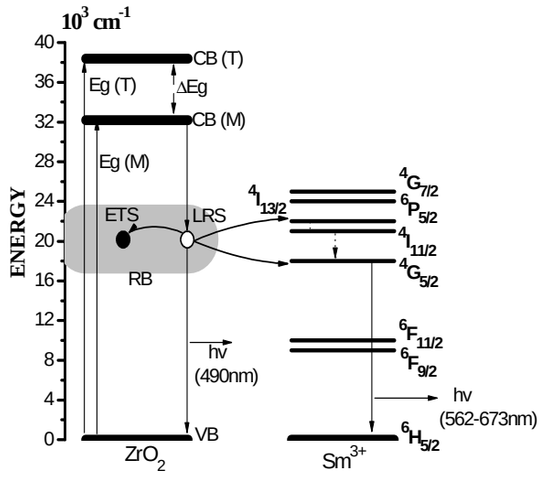

Figure 1. Energy diagram of the Sm^{3+} observed absorption band and the band gap of the host for the tetragonal and the monoclinic structure. It is also described the three channels of LRS relaxation, the non-radiative energy transfer to the Sm^{3+} ions, the non-radiative energy transfer to the ETS and the luminescent relaxation.

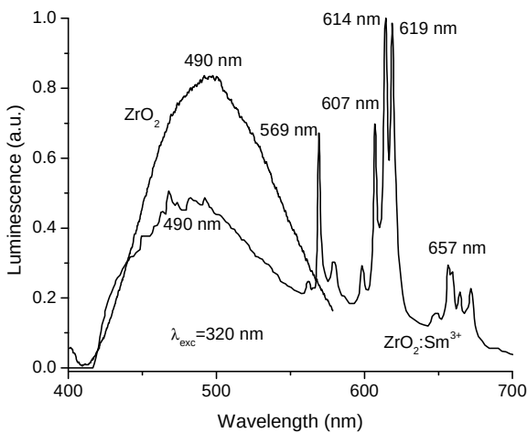

Figure 2. Fluorescence emission of undoped and doped samples (1.5 mol% Sm_2O_3) excited at 320 nm.