Structural characteristic of ZrO_2 nanophosphor codoped with Er3+ and Yb3+ for luminescence applications. C. Angeles-Chavez (1), P. Salas(1), E. de la Rosa-Cruz(2), L. A. Díaz-Torres(2). (1) Programa de Ingenieria Molecular. Instituto Mexicano del Petroleo, Eje Central Lazaro Cardenas No. 152, Mexico D.F.C.P. 07730 Mexico, (2) Centro de Investigaciones en Optica A.C. Leon, Guanajuato, C.P. 37150, Mexico. cangeles@imp.mx

An enormous interest has been shown in the literature on the upconversion process by materials, crystals and glasses, doped with trivalent rare earth ions. The upconversion (UC) is a well-known phenomena used in different applications such as, visible solid state lasers, high density optical data storages, color displays, sensors and security [1-2]. Little attention has received the study of ions with visible emission by upconversion process; perhaps the most studied is the Er3+ ion that has been supported in different matrices such as Y_2O_3, YAG, GGG and ZrO_2.[3]. The results reveal a high efficiency. However, is being actually very important to produce materials with the two process types: Upconversion and downconversion. In this work we report the structural characteristic of a material codoped with Yb3+-Er3+. This material promise to improve the luminescence property than ZrO_2 doped with only Er+3. The Yb3+-Er3+ -codoped ZrO_2 nanoparticles were prepared by using the sol-gel method. The samples were aged at room temperature, dried at 120 °C for 24 h and annealed at 1000 °C for 10 h. The crystalline structure and crystallite size of the samples were investigated by X-ray diffraction (XRD) and transmission electron microscopy (TEM). The optical absorption spectra were measured with a Perkin-Elmer UV–VIS–NIR Lambda 900 spectrophotometer using a 1.5 in. integrating sphere (Labsphere Co.). The powder XRD patterns show the presence of the tetragonal phase for 2 and 4 mol % Yb_2O_3 -1 mol % Er_2O_3-ZrO_2 and cubic at 8 mol % Yb_2O_3-1 mol % Er_2O_3-ZrO_2 with average crystallite size of 77.8, 64.8 and 79.3 nm, and cell volume 67.09, 67.15 and 134.88 Å3 respectively. The phase composition and average crystallite size for the crystalline structure of ZrO_2 was obtained by using the Rietveld method. This means that the metastable tetragonal and cubic structure is stabilized as function of the dopant (Yb3+) concentration. The typical crystallite size observed by Transmission electron microscopy is illustrated in figure 1. Both samples are formed generally by nanoparticles around of 80 nm and a small portion by nanoparticles around of 5 nm. The main contribution in crystallite size corresponds to the nanoparticles around of 80 nm which is in perfectly agreement with the XRD results. From the nanoparticles around of 5 nm was obtained high-resolution transmission electron microscopy image (Figure 2) of each sample (2,4 and 8 mol % Yb_2O_3 -1 mol % Er_2O_3-ZrO_2). Fast Fourier Transform pattern were obtained from HRTEM image, which were analyzed to identify the structure type. Tetragonal and cubic zirconia phases were the main phases found in the samples. The sample with 2 mol % Yb_2O_3 -1 mol % Er_2O_3-ZrO_2 only was identified the tetragonal phase while in the sample with 8 mol % Yb_2O_3-1 mol % Er_2O_3-ZrO_2 was found only the cubic phase. Therefore, both metastable tetragonal and cubic phases can be stabilized as a function of the Yb3+ concentration. Also, the luminescence results, the presence of Yb3+ ion plays a decisive role in the fluorescence emission obtained enhancing not only the typical green an red emission but also the blue emission band.

References

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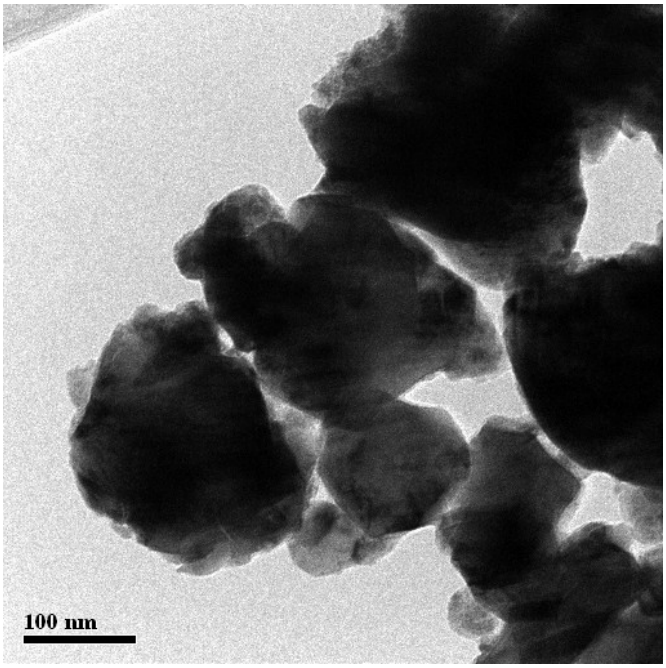

Figure 1. TEM micrograph showing the typical morphology and crystal size obtained of the samples with 2,4 and 8 mol % Yb_2O_3 -1 mol % Er_2O_3-ZrO_2.

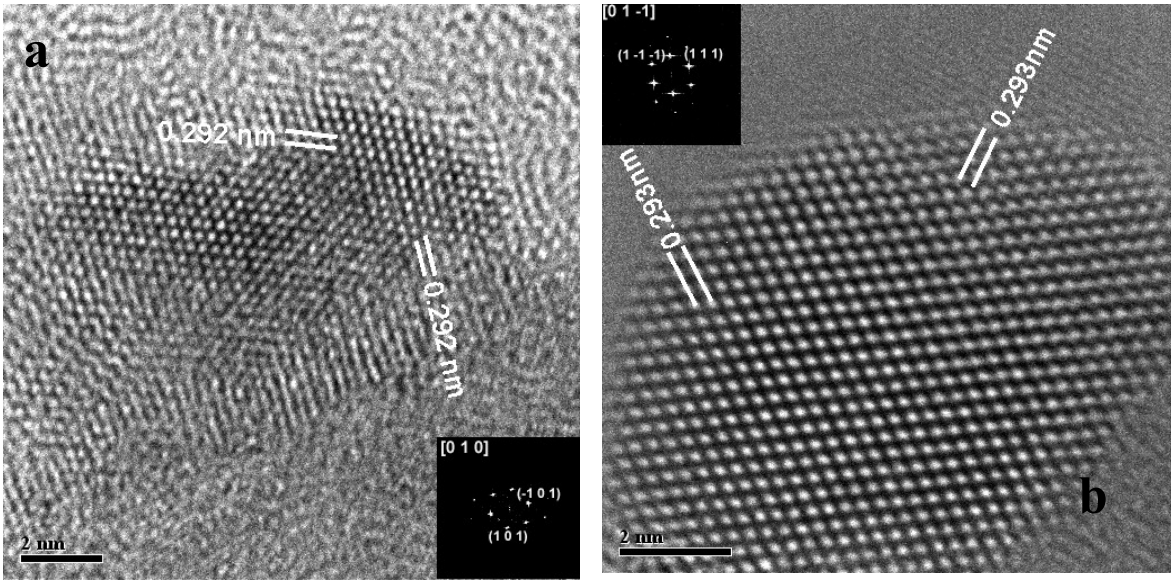

Figure 2. HRTEM images a) corresponding to the codoped tetragonal zirconia phase in the [0 1 0] direction and b) corresponding to the codoped cubic zirconia phase in the [0 1 –1] direction.