Synthesis and Characterization of Thermoluminescent Materials*

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Abstract*– Pure and doped Yttria nanocrystals have been synthesized by precipitation and combustion at 600 ºC. Precipitation products present a spherical morphology of around 20 nm diameter, whereas combustion products are irregular nanocrystals with sizes between 50 and 100 nm. All crystals present a cubic phase. Diffuse reflectance and XR fluorescence indicate the inclusion of dopant ions into the Y_2O_3 crystallite lattice. Morphological and luminescence evaluation has been performed and results are presented.

Keywords-- Thermoluminescent materials, Yttria.

I. INTRODUCTION

Luminescence is a phenomenon of light emission of some solids called phosphors. The purpose of this work was the synthesis and characterization of materials with phosphorescent properties. Particularly, yttrium oxides were synthesized with and without dopants. The importance of this material is that it has been reported [1] to have luminescent properties that make it a potential material for use as a dosimeter.

Many other materials are known and investigated today for these purposes [2,3]. Such is the case of lithium fluoride, which is perhaps the best studied thermoluminescent material whose use is more widespread [4]. However, with the advent of new methods of radiotherapy, as well as the advancement of technology, the development of new materials with phosphorescent properties is now a very active area of research.

II. MATERIALS AND METHODS

The synthesis of yttria-doped cerium in this work was carried out by two different methods. First, the precipitation method was used, and finally the material was synthesized using the combustion method.

For the synthesis of doped Yttria Cerium (precipitation) they were used: 0.0347g of $CeNO_3$ and 5.524 g of YNO_3.

With this amount of precursor material was obtained at the end of the synthesis were obtained 0.897g without NaOH after calcination at 650 °C and 1.115g / with NaOH after calcination at.650 °C, respectively. The NaOH was used as a reaction catalyst.

Different samples were prepared varying the concentration of Ce as a dopant as also the method of preparation: Y_2O_3:0.5%Ce by precipitation with NaOH and without NaOH, Y_2O_3:0.5%Ce by combustion and Y_2O_3:0.1%Ce by combustion.

In this work are presented the results of characterization of the samples synthesized by precipitation.

III. RESULTS AND DISCUSSIONS

Figure 1 shows the structure of peaks presented by a sample of Y_2O_3:0.5%Ce by precipitation without NaOH, measured by X-ray diffraction (XRD). From figure it is observed a series of peaks very well defined and narrow. This can be interpreted, which can be interpreted as the presence of a well-defined crystal structure of this material.

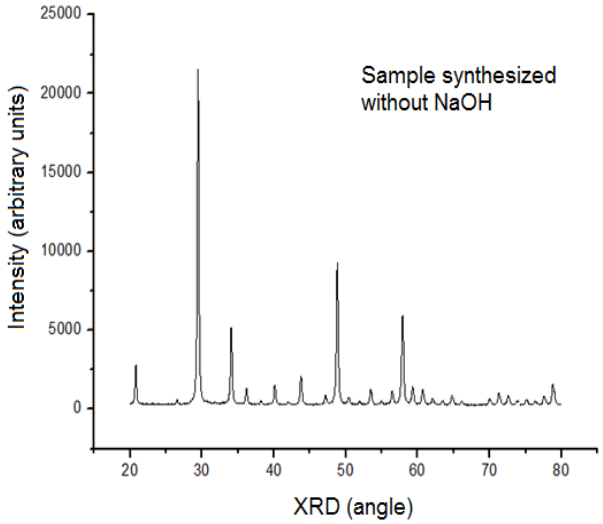

Figure 1. XRD of a Y_2O_3:0.5%Ce sample synthesized by precipitation.

Likewise, Figure 2 shows a photograph of scanning electron microscopy (SEM) for the same sample, obtained by a 100,000 magnification. The Figure shows well defined and uniform nano-crystals.

From these two previous studies it is shown that the synthesis of Y_2O_3:0.5%Ce by precipitation produces a material with a well defined crystalline morphological structure.

On the other hand, Figures 3 and 4 show the same type of graphs for both XRD and SEM for a similar sample of

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Y_2O_3:0.5%Ce, obtained by precipitation, but with NaOH. In addition, two aliquots were prepared, the first at 400 ^{0}C calcination and the second at 650 ^{0}C. In Figure 3 results at 400 ^{0}C correspond to the black line, while the red line represents data at 650 ^{0}C for XRD.

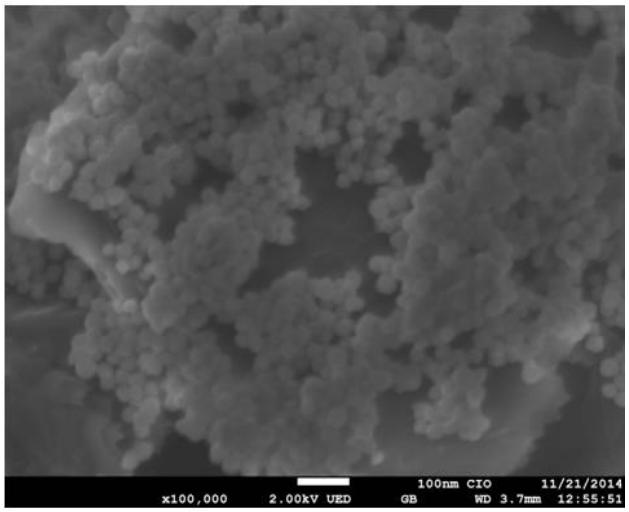

Figure 2. SEM micro-photograph of a Y_2O_3:0.5%Ce sample synthesized by precipitation.

As in Figure 1, clear peaks are observed in Figure 3 for the sample calcinated at 650 ^{0}C. In fact, no difference is observed with respect to the results given in Figure 1. However, the sample at 400 ^{0}C shows much broader peaks, which can be interpreted as a less crystalline phase.

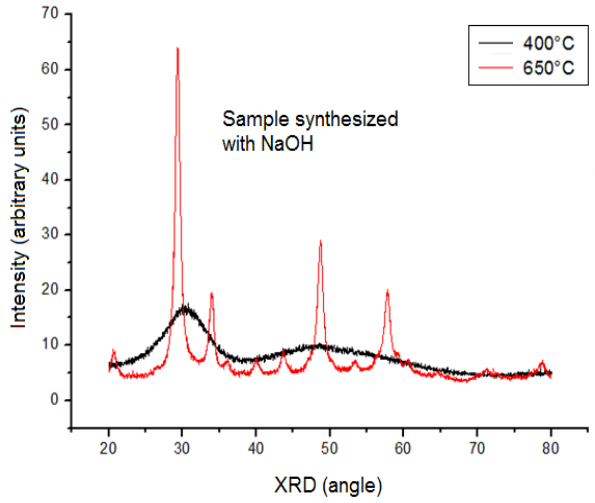

Figure 3. XRD of a Y_2O_3:0.5%Ce sample synthesized by precipitation with NaOH at two different temperatures of calcination.

For its part, Figure 4 shows the SEM photographs for the same sample. Figure 4(a) corresponds to the sample synthesized at 400 ^{0}C, while Figure 4(b) shows the sample at 650 ^{0}C. The data of SEM confirm what was observed by XRD, that is, the material is in a much less crystalline phase when the temperature is lower.

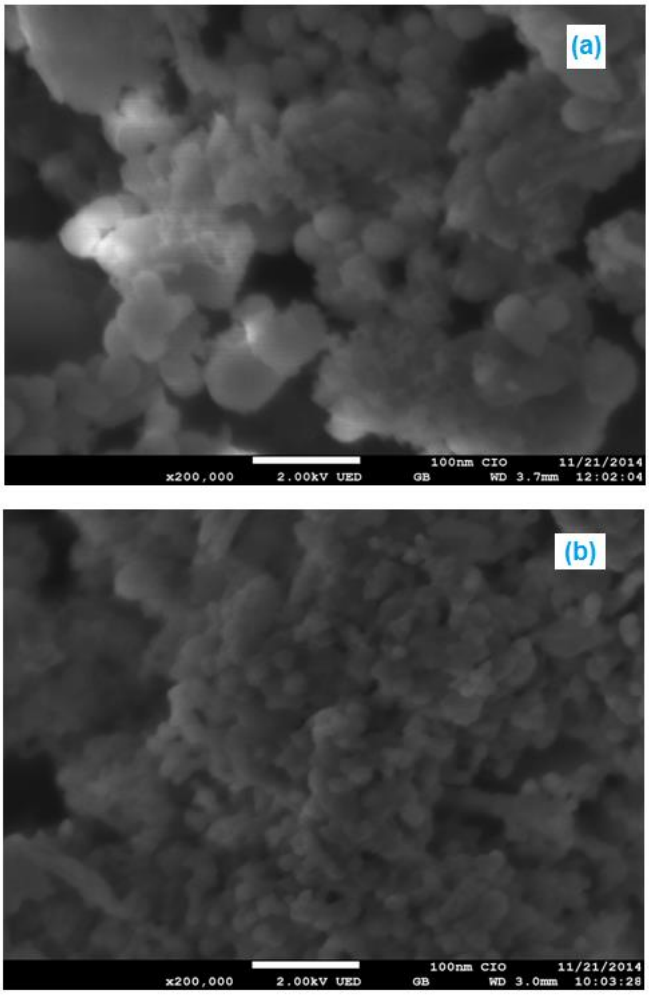

Figure 4. SEM micro-photograph of a Y_2O_3:0.5%Ce sample synthesized by precipitation with NaOH at two different temperatures of calcination.

CONCLUSIONS

Nanocrystals cerium doped yttrium have been synthesized using the precipitation method. Crystals were synthesized both in a medium without NaOH and in a medium with NaOH as reaction catalyst, respectively.

The morphology of the synthesized materials as both XRD was studied with SEM. The results show that the crystalline phase is not dependent on the presence of the catalyst NaOH. However, the crystal structure shows a clear dependence on the calcination temperature. At low temperatures increases the amorphous character of the material and vice versa.

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