11th International Conference
on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Nanocrystalline $CeO_{2-\delta}$:M (M = Ni, Fe, Co) by the Proteic Sol-Gel Process: Synthesis and Characterization

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Abstract – Nanocrystals of doped CeO_2 were prepared by the proteic sol-gel process using coconut water as organic precursor. The obtained xerogel was calcined at 400°C for decomposition of salts and organic material. A endothermic reaction happens just before 400°C where crystallites of 10 nm of doped CeO_2 are obtained, conform to TGA e XRD. Two absorption bands at 274 and 346 nm in the ultraviolet range were found and the energy gap was around 3.2 eV. The vibrational mode between Ce-O was identified around 461 cm^{-1} by Raman spectroscopy, indicating a doped CeO_2 single phase formation.

The cerium oxide is known for possessing interesting properties due its electronic configuration, support to deviations in stoichiometry ($CeO_{2-\delta}$, where $0 < \delta < 0,5$) maintaining a fluorite-type structure. These properties permit a great variety of applications, mainly for catalysis, storage of oxygen [1], ultraviolet absorbing and high precision glass polishing [2]. Recent works suggest the use in spintronic devices when doped with magnetic ions, due to its electronic configuration and structural properties similar to silicon. In this work, we studied the preparation of cerium oxide doped with transition metal, $CeO_{2-\delta}$:M (M = Ni, Fe, Co), through proteic sol-gel process. This process has been successfully used in the production of magnetic oxides [3] and nanoparticles [4]. The process uses coconut water (*cocos nucifera*) as an organic precursor for formation of the sol, where the metal ions are anchored to chains of molecules present in organic solvent. The materials used as precursors in the preparation of our samples were the cerium ammonium nitrate, the dopant salt nitrate, and filtered coconut water. These materials were used in suitable amounts for formation of the sol (about 3 g of salt in 5 ml of organic solvent), which was then dried in furnace for 24h at 100 °C. The obtained xerogel was submitted to calcination at 400 °C for 1 hour in air for decomposition of salts and organic material and to complete formation of cerium oxide. Thermogravimetric analysis show a strong endotermic reaction with temperature varying with the concentration of dopant. All samples showed only the cerianite cubic structure (with space group Fm-3m) in the XRD and the peaks of CeO_2 were identified using JCPDF 34-0394 (fig.1). The crystallite size (calculated using the Scherrer equation) vary around of 10 nm, according to the variation of concentration and of the ion dopant. The spectra of all samples showed two strong absorption bands at 274 and 346 nm in the ultraviolet range and the energy gap was around 3.2 eV and depend of dopant concentration. The characteristic vibrational mode of the Ce-O was identified around 461 cm^{-1} as Raman spectroscopy (fig.2). Such results indicate the presence of a single phase of $CeO_{2-\delta}$:M produced by the proteic sol-gel process.

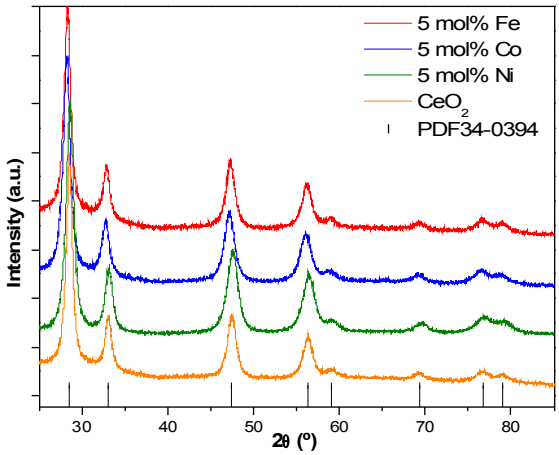

Figure 1: XRD patterns of $CeO_{2-\delta}$:M samples.

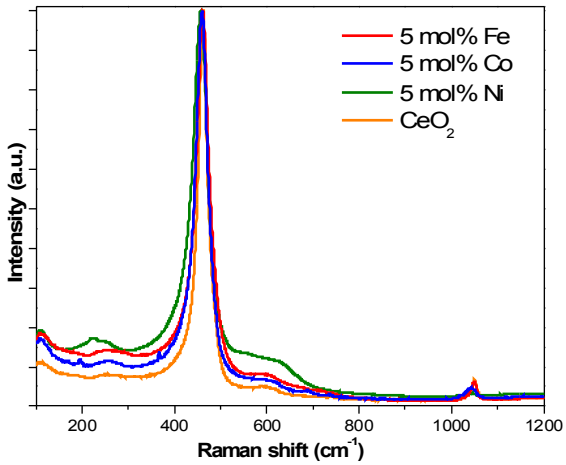

Figure 2: Raman spectra of $CeO_{2-\delta}$:M samples.

References

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