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Fabrication of Ceria Nanowires by Inorganic hydrothermal growth

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Abstract: The nano structures (nanowires and nanoparticles) of rare earth compound, cerium oxide, were synthesized. These nano particles were prepared by hydrothermal method. High purity cerium oxide was the starting material. The mixture was hydrothermally treated. The critical factors in the nano structured growth were temperature, pH and crystal structure. Structural characterization was done by X-ray diffraction,energy dispersive X-ray diffraction, scanning electron microscopy and atomic force microscopy. The particle size and the diameter of grown wires were in the range 14-21nm.These nano wires have applications as CO and CO_2 sensors and also as bio sensing and bio labeling.

The minimal amount of rare earth compound cerium oxide was dissolved in concentrated nitric acid. Sodium hydroxide was used as precipitating agent. The precipitates were stirred for ten minutes. Then the precipitates were put in autoclave which was filled up to eighty percent with de-ionized water. Overnight treatment was done at one eighty degrees celsius. After treatment precipitates were allowed to cool. Washing and filtration was done with de-ionized water. Drying was done at sixty degrees celsius. The obtained specimen was examined by X-ray diffraction (XRD), Energy dispersive X-ray diffraction (EDX),Scanning electron microscope (SEM) and Atomic force microscope (AFM).

Synthesis of rare earth nano structures was based on co-precipitated hydrothermal method. Cerium oxide (the starting material) has hexagonal crystal structure. Scanning Electron Microscopy (figures 1) and X-ray diffraction (figure 2) confirmed the hexagonal shape of the obtained nanostructures. Energy dispersive X-ray diffraction also confirmed the presence of cerium and oxygen. The growth of nano wires is attributed to the crystal structure, the pH value, temperature and pressure exerted on the colloidal particles inside the closed vessel. This same growth of the nanostructures is an example of the 'invariant' crystal growth. Gibbs-Curie-Wulff model suggested that equilibrium shape of a crystal is related to the free energies of the faces. The rate of growth is proportional to the surface energies of the faces [1-3]. The hydrothermal method is catalyst free and template free method for growth of nano wires as compared with others [4]. The specified growth is considered to be due to the original crystal structure of starting material and the chemical potential which for this case is determined from the pH value as suggested by the Gibbs-Curie-Wulff model [1].

The nanostructures of cerium oxide were synthesized by co-precipitated hydrothermal method successfully. SEM and XRD revealed the hexagonal shape of the nanostructures. SEM and AFM showed the coexistence of nano particles and nano wires. XRD confirmed the coexistence of cerium hydroxide and cerium oxide in nano regime. The estimated particle size from XRD data is 14-21 nm. The prepared specimen has applications as carbon dioxide sensor and in biological labeling.

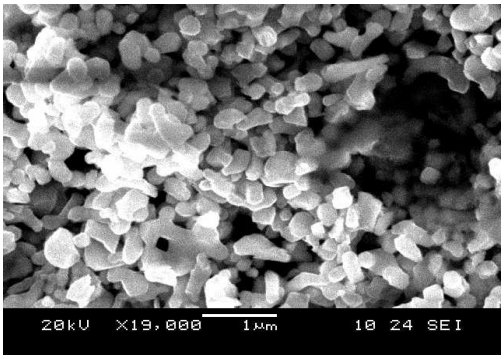

Figure 1: Scanning Electron Microscopy (SEM) Image of the nano wires of prepared specimen

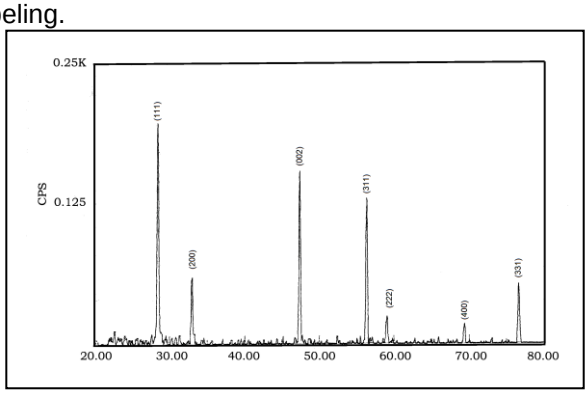

Figure 2: X-ray diffraction (XRD) Pattern of prepared specimen CeO_2

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