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SPID 10846

Abstract Number: FF12.33 **Day / Time:** Thursday, Nov. 29, 8:00 PM - 11:00 PM

Study of the Influence of the Microwave Heating in Growth of Gadolinium doped Cerium Oxide Nanorods.

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Ceria and doped ceria are rare earth oxides that have been extensively studied and applied in catalysis, electrochemistry, UV blockers, and polishing materials. The main reason for this interest in ceria based anisotropic nanocrystals is the possibility to develop catalyst materials with high surface area and well-defined reactive crystal planes with superior catalytic activity. The gadolinium doped ceria nanorods (GCNr), with nominal composition Gd0.2Ce0.8O2-x, were synthesized by hydrothermal treatment of a colloidal suspension of gadolinium doped ceria nanocrystals (GCNc) in an aqueous solution. TEM characterization of the material after hydrothermal treatment in microwave oven showed the presence of GCNr and GCNc. The GCNr presented length raging from 50 to 500 nm and diameter raging from 20 to 60 nm. In the present work, the use of microwave heating allowed to use shorter treatment time (3 min.). In a control experiment running under hydrothermal condition, using traditional heating (EO) and keeping constant the experimental parameters (temperature, time, composition and pressure) did not showed the formation of GCNr. It is observed only the formation of GCNc with particle size raging from 10-15 nm. The aggregation of several nanocrystals with similar crystallographic orientation originating a single nanorod and the presence of defects, are strong evidence that the oriented attachment (OA) process is the dominant nanocrystal growth mechanism during the process of GCNr. This result clearly shows that under microwave heating, the formation of nanorods is speed up. The HRTEM results revealed that the diameter dimensions of the nanorod are related to the lattice direction (002). This crystallographic information indicates the formation of nanorods with preferential growth in the [110]. This growth direction is in agreement with the fact that the driving force for the coalescence process in the oriented attachment mechanism is related to the reduction of surface energy, aimed at minimizing the area of high-energy faces. In a cubic system, the {111} plane is the more stable (it presents the lowest surface energy). Thus growth in {110} or {001} is expected. In summary, the use of microwave during the hydrothermal treatment decrease drastically the treatment time to obtain doped ceria nanorods and that the OA is the dominant mechanism responsible for anisotropic growth.

Citation: M.Godinho, C.Ribeiro, R.F.Goncalves, E.Longo, E.R.Leite. Study of the Influence of the Microwave Heating in Growth of Gadolinium doped Cerium Oxide Nanorods.. Abstract No. FF12.33. *2007 Abstract Viewer.* Boston, MA: Materials Research Society