Defect states and room temperature ferromagnetism in cerium oxide nanopowders prepared by decomposition of Ce-propionate - DTU Orbit (11/08/2019)

Defect states and room temperature ferromagnetism in cerium oxide nanopowders prepared by decomposition of Ce-propionate

Four batches of cerium oxide powders (with nanocrystallite size of 6.9nm–572nm) were prepared from four precursor nanopowders by thermal decomposition of Ce-propionate and annealing in air between 250°C–1200°C for 10min–240min. Ceria formation reactions, structure, vibrational, luminescence and magnetic properties were investigated by differential scanning calorimetry, x-ray diffraction, electron microscopy, infrared spectroscopy, photoluminescence and SQUID. All the samples exhibit room temperature ferromagnetism, RTFM, (with coercivity, \(H_c\), of 8Oe - 121Oe and saturation magnetization, \(M_s\), of up to \(6.7*10^{-3}\)emu/g) and a broad defect-related photoluminescence, PL, emission in the visible range. The samples derived from the same precursor show \(M_s\) proportional to the peak area of defect-related PL emission whereas this is not valid for the samples derived from the different precursors. An improvement of ferromagnetism and intensity of defect-related PL emission was observed when annealing the products in which nanocrystalline cerium oxide coexists with Ce - oxicarbonate traces, Ce\(_2\)O\(_2\)CO\(_3\). The experimental results were explained based on the following considerations: room temperature ferromagnetism was induced by the defective ceria with high concentration of oxygen vacancies generated by decomposition of Ce-propionate; oxygen vacancies of the starting precursor nanopowders could be redistributed (at the surfaces/grain boundaries, GBs) upon heating under conditions that promote an inert local environment; the decomposition of Ce\(_2\)O\(_2\)CO\(_3\) residues can provide an excess of oxygen vacancies at the nanoparticles surfaces or GBs, which can induce or enhance ferromagnetism; surfaces/GBs rather than bulk defects appear responsible for RTFM – this can explain the (often reported in literature) inconsistency between oxygen vacancies concentration and \(M_s\).

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