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Structural and magnetic properties of $CoFe_{1.9}RE_{0.1}O_4$ (RE = Y, La) prepared by a sol–gel method

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Abstract

Ultrafine $CoFe_{1.9}RE_{0.1}O_4$ (RE = Y, La) powders have been fabricated by a sol–gel method. Structural and magnetic properties of the powders were investigated by X-ray diffractometer, Mössbauer spectroscopy, and vibrating sample magnetometer. The $CoFe_{1.9}Y_{0.1}O_4$ powders that were fired at and above 923 K contained only a single spinel phase and behaved ferrimagnetically. Powders fired at 723–823 K had a spinel structure and were mixed paramagnetic and ferrimagnetic in nature. Mössbauer spectra of the $CoFe_{1.9}Y_{0.1}O_4$ powder fired at 923 K were taken at various temperatures ranging from 18 to 865 K. The iron ions at both A (tetrahedral) and B (octahedral) sites were found to be in ferric high-spin states. The Néel temperature T_N was found to be 865 ± 2 K. Debye temperatures for A and B sites were found to be $\Theta_A = 695 \pm 5$ K and $\Theta_B = 279 \pm 5$ K, respectively. The magnetic behaviors of the $CoFe_{1.9}Y_{0.1}O_4$ powders fired at and above 1123 K and $CoFe_{1.9}La_{0.1}O_4$ powders fired at and above 923 K, respectively, showed that an increase of the firing temperature yielded a decrease in the coercivity and an increase in the saturation magnetization. The maximum coercivity and the saturation magnetization were $H_c = 1208$ Oe and $M_s = 69$ emu/g in the $CoFe_{1.9}Y_{0.1}O_4$ samples and $H_c = 703$ Oe and $M_s = 72$ emu/g in the $CoFe_{1.9}La_{0.1}O_4$ samples.

Keywords: Mössbauer spectroscopy; Sol–gel method; Vibrating sample magnetometer