Magnetic and structural properties of ultrafine $CoFe_{1.9}RE_{0.1}O_4$ (RE=Gd,Nd) powders grown by using a sol-gel method

Woo Chul Kim, Sam Jin Kim, and Chul Sung Kim[a)]
Department of Physics, Kookmin University, Seoul 136-702, Korea

Ultrafine $CoFe_{1.9}RE_{0.1}O_4$ (RE=Gd, Nd) powders have been fabricated by a sol-gel method. Magnetic and structural properties of the powders were investigated by x-ray diffractometer, Mössbauer spectroscopy, and vibrating sample magnetometer. The $CoFe_{1.9}Gd_{0.1}O_4$ powders that were fired at and above 923 K contained only a single spinel phase and behaved ferrimagnetically. The grain diameters were estimated to be 11–30 nm for the Co-Gd ferrite powders fired in 773–1123 K. Mössbauer spectra measurements showed that the $CoFe_{1.9}Gd_{0.1}O_4$ powders fired at 723–823 K and the $CoFe_{1.9}Nd_{0.1}O_4$ powders fired at 523–1023 K had a spinel structure and were mixed paramagnetic and ferrimagnetic in nature. Mössbauer spectra of the Co–Gd ferrite powder fired at 923 K were taken at various temperatures ranging from 14 to 875 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 875 ± 2 K. Debye temperatures for *A* and *B* sites were found to be $\Theta_A=640\pm5$ K and $\Theta_B=217\pm5$ K, respectively. The magnetic behaviors of the $CoFe_{1.9}Gd_{0.1}O_4$ powders fired at and above 723 K, and $CoFe_{1.9}Nd_{0.1}O_4$ 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 $H_c=1{,}149$ Oe and $M_s=72$ emu/g in the $CoFe_{1.9}Gd_{0.1}O_4$ samples and $H_c=959$ Oe and $M_s=63$ emu/g in the $CoFe_{1.9}Nd_{0.1}O_4$ samples. © *2002 American Institute of Physics.* [DOI: 10.1063/1.1452214]