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Magnetic properties of Y-, La-, Nd-, Gd-, and Bi-doped ultrafine $CoFe_2O_4$ spinel grown by using a sol–gel method

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Abstract

Y-, La-, Nd-, Gd-, and Bi-doped ultrafine $CoFe_2O_4$ particles are fabricated by using a sol–gel method. Magnetic and structural properties depending on annealing temperature of powders are investigated with X-ray diffractometer (XRD), Mössbauer spectroscopy, and vibrating sample magnetometer (VSM). Y-, Gd-, and Bi-doped samples fired at and above 923 K have only a single cubic spinel strcture and behave ferrimagnetically, but in La- and Nd-doped samples α-Fe_2O_3 phase was observed at and above 1123 K. Powders annealed at 823 K have a typical spinel structure and have a paramagnetic and ferrimagnetic nature, simultaneously. The isomer shifts of all samples indicated that the iron ions were ferric at the tetrahedral [A] and the octahedral sites [B], respectively. The magnetic behavior of $CoFe_{1.9}Bi_{0.1}O_4$ and $CoFe_{1.9}Nd_{0.1}O_4$ spinel powders fired at and above 923 K shows that an increase of the annealing temperature yields a decrease of the coercivity and an increase of the saturation magnetization. The highest coercivity of 1368 Oe and saturation magnetization of 76.2 emu/g are observed in $CoFe_{1.9}Bi_{0.1}O_4$ compound.

Keywords: Sol-gel method; Ultrafine particles; Mössbauer spectroscopy; VSM