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Growth of ultra-fine cobalt ferrite particles by a sol–gel method and their magnetic properties

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Ultra-fine $CoFe_2O_4$ particles are fabricated by a sol–gel method and magnetic and structural properties of powders are investigated. Cobalt ferrite powders fired at and above 450 °C have only a single-phase spinel structure and behave ferrimagnetically. Powders annealed at 350 °C have a typical spinel structure and are of the paramagnetic and ferrimagnetic nature, simultaneously. With X-ray diffraction and Mössbauer spectroscopy measurements, the formation of nano-crystallized particles is confirmed when cobalt ferrite is annealed at 200 °C. In addition, the transition from the paramagnetic to the ferrimagnetic state is observed in samples fired at 200 °C as the measuring temperature decreases from the room to liquid nitrogen temperature. The magnetic behaviour of $CoFe_2O_4$ powders fired at and above 350 °C shows that an increase of the annealing temperature yields a decrease in the coercivity and, in contrast, an increase in the saturation magnetization. The maximum coercivity and the saturation magnetization of cobalt ferrite powders prepared by the sol–gel method are 2020 Oe and 76.5 e.m.u. g^{-1}, respectively.