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Journal of Magnetism and Magnetic Materials 300 (2006) 300–305
Journal of magnetism and magnetic materials
www.elsevier.com/locate/jmmm

Magnetic and optical properties of spinel $Fe_xCo_{3-x}O_4$ thin films

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Received 28 March 2005; received in revised form 12 May 2005
Available online 14 June 2005

Abstract

Magnetic and optical properties of $Fe_xCo_{3-x}O_4$ thin films grown by sol–gel method have been investigated as the Fe composition (x) increases from 0 to 2. X-ray diffraction measurements revealed that the normal- and inverse-spinel phases coexist for $0.76 \leqslant x \leqslant 0.93$. The normal-spinel phase is dominant below $x = 0.76$ while the inverse-spinel phase above $x = 0.93$. The lattice constant of the inverse-spinel phase is found to be larger than that of the normal-spinel phase. For both phases the lattice constant increases with increasing x. The $Fe_xCo_{3-x}O_4$ films containing the inverse-spinel phase exhibit net magnetization that increases with increasing x. Conversion electron Mössbauer spectrum measured on the $x = 0.93$ sample showed that Fe^{2+} ions prefer the octahedral sites, indicating the formation of the inverse-spinel phase. Analysis on the measured optical absorption spectra for the samples by spectroscopic ellipsometry indicates a dominance of the normal-spinel phase for low x in which Fe^{3+} ions mostly occupy the octahedral sites. Observation of a crystal-field transition at 1.6 eV originating from tetrahedral Fe^{3+} ion confirms the existence of the inverse-spinel phase for high x.

PACS: 75.50.−y; 75.70.−i; 78.20.Ci

Keywords: Spinel; Phase transition; Magnetization; Optical absorption