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Structural, Magnetic, and Optical Studies on Normal to Inverse Spinel Phase Transition in $Fe_xCo_{3-x}O_4$ Thin Films

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Phase transition from normal- to inverse-spinel structure has been observed for $Fe_xCo_{3-x}O_4$ thin films as the Fe composition (x) increases from 0 to 2. The samples were fabricated as thin films by sol-gel method on Si(100) substrates. X-ray diffraction measurements revealed a coexistence of two phases, normal and inverse spinel, for $0.76 \le x \le 0.93$. The normal-spinel phase is dominant for $x \le 0.55$ while the inverse-spinel phase for $x \ge 1.22$. The cubic lattice constant of the inverse-spinel phase is larger than that of the normal-spinel phase. For both phases the lattice constant increases with increasing x. X-ray photoelectron spectroscopy measurements revealed that both Fe^{2+} and Fe^{3+} ions exist with similar strength in the x=0.93 sample. Conversion electron Mössbauer spectra measured on the same sample showed that Fe^{2+} ions prefer the octahedral Co^{3+} sites, indicating the formation of the inverse-spinel phase. Analysis on the measured optical absorption spectra for the samples by spectroscopic ellipsometry indicates the dominance of the normal spinel phase for low x in which Fe^{3+} ions tend to substitute the octahedral sites.

Key words : spinel, crystal structure, optical absorption, magnetic hysteresis, Mössbauer spectroscopy