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Phase Decomposition and Related Structural and Magnetic Properties of Iron-cobaltite Thin Films

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Iron-cobaltite ($Co_{3-x}Fe_xO_4$) thin films exhibited a spinodal decomposition (SD) into two distinct cubic spinel phases as the Fe composition was varied near $x = 1$. Polycrystalline films of spinel oxides ($x \leq 2.0$) were prepared on Si(100) substrates by using a sol-gel deposition, followed by subsequent air-annealing at 800 °C. X-ray diffraction results revealed that the two coexisting spinel phases (I and II) in the SD region had different lattice constants by about 2% ($a_{\mathrm{I}} < a_{\mathrm{II}}$). Phases I and II were found to have Fe compositions of about 0.5 and 1.5, respectively. The X-ray photoelectron spectroscopy investigation indicated that the Fe ions mainly had a valence of +3 for all Fe compositions. Magnetic hysteresis measurements revealed that phase II had a magnetization strength larger than that of phase I by about 20 times. These experimental results imply specific site preference of Co^{2+} ions for the two phases of the SD region: tetrahedral sites for phase I and octahedral sites for phase II.

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