

PE02

Superexchange Interactions in Various Spinel Ferrites

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Spinel ferrites, $M\text{Fe}_2\text{O}_4$ ($M=\text{Ni, Mg, Co, Li}$) samples were prepared by sol-gel method. It has been studied by x-ray diffraction, Mössbauer spectroscopy. X-ray diffraction patterns were analyzed by the Rietveld refinement. The samples have been cubic spinel structure with the lattice constant (a_0) is 8.326 ~ 8.390 Å. The temperature dependence of the magnetic hyperfine field is analyzed by the Néel theory of ferrimagnetism. The intersublattice A-O-B and intrasublattice A-O-A superexchange interactions are found to be antiferromagnetic while the intra-sublattice B-O-B superexchange interaction is ferromagnetic for the $M\text{Fe}_2\text{O}_4$ ($M=\text{Ni, Mg, Co}$) samples as shown in Table I. On the other hand, the intersublattice superexchange interaction is found to be antiferromagnetic while the intrasublattice superexchange interactions are ferromagnetic for the Li-ferrite sample.

Table I. The intersublattice JA-B and intrasublattice JA-A and JB-B superexchange interactions for the $M\text{Fe}_2\text{O}_4$ ($M=\text{Ni, Mg, Co, Li}$) samples.

	J_{A-B} (kB)	J_{A-A} (kB)	J_{B-B} (kB)	T_N (K)	a_0 (Å)
NiFe_2O_4	-25.7	-4.0	4.2	860	8.326
MgFe_2O_4	-10.0	-0.7	1.4	710	8.390
CoFe_2O_4	-25.0	-18.9	3.9	870	8.381
$\text{Li}_{0.5}\text{Fe}_2\text{O}_4$	-10.7	16.5	20.6	912	8.334

PE03

Effects of Vanadium Substitution on Structural, Electronic, Magnetic, and Optical Properties of Inverse-spinel Fe_3O_4

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As one of the iron oxides, Fe_3O_4 is known to be half-metallic with highly spin-polarized conduction electrons, in which an energy gap exists in the majority-spin bands while no energy gap exists in the minority-spin bands. The tetrahedral ions have spin direction opposite to the octahedral ones, exhibiting ferrimagnetism below 858 K.

In this work, structural, electronic, magnetic, and optical properties of $V_x\text{Fe}_{3-x}\text{O}_4$ ($x \leq 1.0$) thin films have been investigated. Substituting V ions were found to take a valence of +3 mainly with minor population of +2. These V ions tend to substitute the octahedral sites. Saturation magnetization and coercivity of the samples measured by vibrating sample magnetometry are shown in Fig. 1. The electronic structure of Fe_3O_4 and its variation with V doping was figured out by optical measurements. Optical absorption spectra of $V_x\text{Fe}_{3-x}\text{O}_4$ can be explained in terms of reduction of octahedral Fe^{2+} density through V doping. The spin configuration of the $V_x\text{Fe}_{3-x}\text{O}_4$ films was discussed based on magnetic and electronic structure data.

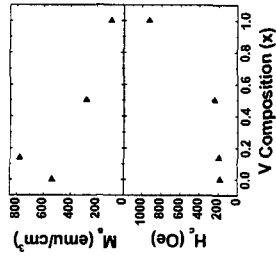


Fig. 1. Saturation magnetization (M_s) and coercivity (H_c) for $V_x\text{Fe}_{3-x}\text{O}_4$ films obtained from vibrating sample magnetometry data measured at room temperature.