

PE02

Superexchange Interactions in Various Spinel Ferrites

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Spinel ferrites, MFe_2O_4 ($M=Ni, Mg, Co, Li$) 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 MFe_2O_4 ($M=Ni, Mg, Co$) samples as shown in Table 1. 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 1. The intersublattice JA-B and intrasublattice JA-A and JB-B superexchange interactions for the MFe_2O_4 ($M=Ni, Mg, Co, Li$) samples.

	J_{A-B} (kB)	J_{A-A} (kB)	J_{B-B} (kB)	T_N (K)	a_0 (Å)
NiFe ₂ O ₄	-25.7	-4.0	4.2	860	8.326
MgFe ₂ O ₄	-10.0	-0.7	1.4	710	8.390
CoFe ₂ O ₄	-25.0	-18.9	3.9	870	8.381
Li _{0.5} Fe _{2.5} O ₄	-10.7	16.5	20.6	912	8.334

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Effects of Vanadium Substitution on Structural, Electronic, Magnetic, and Optical Properties of Inverse-spinel Fe₃O₄

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As one of the iron oxides, Fe₃O₄ 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_xFe_{3-x}O₄ ($x \leq 1.0$) 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 Fe₃O₄ and its variation with V doping was figured out by optical measurements. Optical absorption spectra of V_xFe_{3-x}O₄ can be explained in terms of reduction of octahedral Fe²⁺ density through V doping. The spin configuration of the V_xFe_{3-x}O₄ films was discussed based on magnetic and electronic structure data.

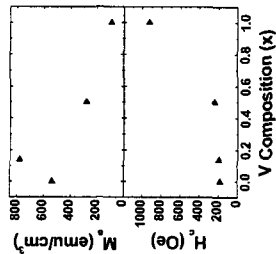


Fig. 1. Saturation magnetization (M_s) and coercivity (H_c) for V_xFe_{3-x}O₄ films obtained from vibrating sample magnetometry data measured at room temperature.