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# Structural Phase Transition, Electronic Structure, and Magnetic Properties of Sol-gel-prepared Inverse-spinel Nickel-ferrites Thin Films

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**X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and vibrating sample magnetometry (VSM) were used to investigate the influence of Ni ions on the structural, electronic, and magnetic properties of nickel-ferrites ($Ni_xFe_{3-x}O_4$). Spinel $Ni_xFe_{3-x}O_4$ ($x \leq 0.96$) samples were prepared as polycrystalline thin films on $Al_2O_3$ (0001) substrates, using a sol-gel method. XRD patterns of the nickel-ferrites indicate that as the Ni composition increases ($x > 0.3$), a structural phase transition takes place from cubic to tetragonal lattice. The XPS results imply that the Ni ions in $Ni_xFe_{3-x}O_4$ substitute for the octahedral sites of the spinel lattice, mostly with the ionic valence of +2. The minority-spin *d*-electrons of the $Ni^{2+}$ ions are mainly distributed below the Fermi level ($E_F$), at around 3 eV; while those of the $Fe^{2+}$ ions are distributed closer to $E_F$ (~1 eV below $E_F$). The magnetic hysteresis curves of the $Ni_xFe_{3-x}O_4$ films measured by VSM show that as x increases, the saturation magnetization ($M_s$) linearly decreases. The decreasing trend is primarily attributable to the decrease in net spin magnetic moment, by the $Ni^{2+}$ (2 $\mu_B$) substitution for octahedral $Fe^{2+}$ (4 $\mu_B$) site.**

**Keywords:** nickel-ferrite, spinel, phase transition, magnetization