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Crystallographic and magnetic properties of Ni$_{1-x}$Cu$_x$Fe$_2$O$_4$ (x=0.0, 0.5, 0.9) by sol-gel method

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Ni$_{1-x}$Cu$_x$Fe$_2$O$_4$ (x=0.0, 0.5, 0.9) samples prepared by sol-gel method have been studied by XRD, VSM and Mössbauer spectroscopy. The crystal is found to be an inverse cubic spinel structure. The variation of lattice constants ($a_0$) obeyed Vegard's law with linearly increases from 8.326 to 8.386±0.005 Å. The magnetic property of Ni$_{0.5}$Cu$_{0.5}$Fe$_2$O$_4$ is found to be $M_s = 36.67$ emu/g and $H_c = 54.75$ Oe measured by VSM. Mössbauer spectra of all samples were obtained at various temperatures ranging from 4.2 to Néel temperature ($T_N$). The spectra show decrease of $T_N$ from 860 to 755±5 K. It can be explained by the superexchange interactions with applied Néel theory of ferrites to the two sublattices of Ni$_{1-x}$Cu$_x$Fe$_2$O$_4$. The iron ions at both A (tetrahedral) and B (octahedral) sites are found to be ferric high-spin states with isomer shift value ($\delta$) = 0.26 mm/s. The Debye temperatures of x=0.9 sample for the A and B sites were found to be 568±5 K and 194±5 K with large difference, respectively.

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