Structural and spectroscopic studies of nanocrystalline Ni$_{1-x}$Mg$_x$Fe$_2$O$_4$ ferrites synthesized by a microwave-assisted combustion route

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Abstract:

In this work, the synthesis of Ni$_{1-x}$Mg$_x$Fe$_2$O$_4$ (0 ≤ x ≤ 1.0) nanoparticles by a facile microwave-assisted combustion method is reported with detailed study of the structural and optical properties. By employing techniques of x-ray diffraction (XRD) with Rietveld refinement, transmission electron microscope (TEM, HRTEM, TEM-EDX), Fourier transform infrared spectroscopy (FTIR) and UV-Visible spectroscopy, the synthesized nanoparticles are characterized and introduced for further study of size-confined properties. Nanocrystals of a pure cubic spinel structured phase with average particle size of 20–40 nm were successfully synthesized in the whole range of x. In consistence with Vegard's law for a solid solution lattice, the lattice constant increases linearly with the substitution for Ni$^{2+}$ with the relatively larger Mg$^{2+}$ cations. The Rietveld analysis of the observed XRD patterns reveals an inversed spinel structure in NiFe$_2$O$_4$ nanoparticles with a decreased inversion factor by Mg-substitution. The results of UV-Visible absorbance indicate a wide energy gap of about 3.6 eV for NiFe$_2$O$_4$ nanoparticles that monotonically tuned towards a narrow band gap by Mg-doping.

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