PREPARATION AND CHARACTERIZATION OF NICKEL DOPED MAGNETITE (Ni\textsubscript{x}Fe\textsubscript{3-\textit{x}}O\textsubscript{4}) NANOPARTICLES COATED BY AMINO SILANE

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The interest in magnetic nanoparticles has grown substantially in recent years due to their extensive use in biomedical applications; those nanoparticles can be obtained by co-precipitation method. Particularly, magnetite nanoparticles are developed as heat mediators in magnetic hyperthermia. Modifying the magnetic anisotropy of magnetite via the total or partial substitution of ferrous ions with Ni\textsuperscript{2+} in their spinel structure enhances the hyperthermic efficiency. In this study, substituted magnetite nanoparticles with nickel, [Fe\textsuperscript{3+}]\textsubscript{\textit{A}}[Fe\textsuperscript{2+}\textsubscript{1-x}Ni\textsuperscript{2+}xFe\textsuperscript{3+}\textsubscript{B}]O\textsubscript{4} with (x=0.0, 0.2, 0.4, 0.6, 0.8 and 1.0) were obtained by co-precipitation reaction, finally these samples were coated by the hydrolysis of aminoethylamino propyltrimethoxysilane.

X Ray Diffraction (XRD) patterns indicate no changes in the crystal structure showing the same diffracted planes. The crystallite size was calculated by Scherrer equation using the main (3 1 1) peak of the cubic spinel structure, it has been found that the crystallite size decrease with the increase of Ni concentration from 10.39 nm to 3.86 nm. Energy-dispersive x-ray spectroscopy (EDS) results showed that the presence of nickel increase with the grade of substitution, as well the presence of Silicon in the coated nanoparticles due to silica shell formed by the amino silane. Fourier transform infrared spectroscopy (FTIR) indicate the presence of vibrational modes of the bounds between N-H, C-N, C-H and Si-O in the range from 600 cm\textsuperscript{-1} to 3700 cm\textsuperscript{-1}, those results indicate that the nanoparticles are coated by amino silane. Magnetic properties of substituted magnetite particles were evaluated using a Vibrating Sample Magnetometer (VSM) under an applied field of 3 T at 300 K. Nickel substitution in the magnetite structure has an effect in the magnetic properties decreasing from 55.84 emu/g to 16.21 emu/g. Variation of divalent ion composition of the particles allows adjusting the magnetic properties leading to a well-controlled regime of magnetic nanoparticles for biomedical applications in hyperthermia.

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References:

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