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Magnetic properties for Zn\textsubscript{0.05}Fe\textsubscript{2.95}O\textsubscript{4} microparticles
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Magnetic properties for Zn$_{0.05}$Fe$_{2.95}$O$_4$ microparticles

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The Zn doped Fe$_3$O$_4$ have been suitable material for biological applications [1]. Zn$_{0.05}$Fe$_{2.95}$O$_4$ have highest saturation magnetization ($M_S$) value at room temperature among the Zn doped iron oxides. The Zn$_{0.05}$Fe$_{2.95}$O$_4$ microparticles were prepared by a solvothermal reaction method. The magnetic and crystallographic properties of sample were investigated using x-ray diffraction (XRD), field emission scanning electron microscope (FESEM), vibrating sample magnetometer (VSM), and Mössbauer spectroscopy. From the XRD results, crystal structure of Zn$_{0.05}$Fe$_{2.95}$O$_4$ sample was found to be cubic spinel ($Fd-3m$) with lattice constant $a_0 = 8.415$ Å. The particle size of the sample was determined to be 574 nm with spherical shape by FESEM measurements. From measured the M-H curve, the $M_S$ and coercivity ($H_C$) value at room temperature of Zn$_{0.05}$Fe$_{2.95}$O$_4$ microparticles were 97.0 emu/g and 83 Oe, respectively. The Mössbauer spectra of Zn$_{0.05}$Fe$_{2.95}$O$_4$ sample at various temperatures were composed of four six-line (trivalent valence state one A site and mixed valence state three B site). From the Mössbauer analysis, the isomer shift value ($\delta$) of A and B$_1$, B$_2$, B$_3$ sites at 4.2 K are 0.42 (Fe$^{3+}$) and 0.33 (Fe$^{3+}$), 0.35 (Fe$^{3+}$), 0.90 (Fe$^{2+}$) mm/s. The magnetic hyperfine field ($H_{hf}$) of A and B$_1$, B$_2$, B$_3$ sites at 4.2 K are 527 and 510, 501, 487 kOe, respectively.