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Novel Synthesis and Characterization of Mn Substituted Fe_3O_4 Nano-Particle

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ABSTRACT:
$MnFe_2O_4$ nanopowders was synthesized by Novel solvothermal method. Sample was characterized by X- ray diffraction, XRD results confirmed the formation $MnFe_2O_4$. Transmission Electron Microscopy (TEM) are used for Morphological study,which indicates the nano particle are well prepared. The Photoluminescence (PL) Spectroscopy indicates that Large PL signals correlate with good interface properties. The UV/VIS Spectroscopy Show different absorption spectrum of $MnFe_2O_4$ particles different concentration of solution.

Keywords:Nano-Particle, Ferrite,TEM, XRD,UV/VIS, Photoluminescence

Introduction

Magnetic behaviour of Nano-particles has been the subject of much interest It has been thought that many novel properties and potential applications would emerge from mono disperse materials with small dimensions. Therefore, the synthesis of mono disperse nanoparticles has been intensively pursued for their technological and fundamental scientific importance[1-5]. The synthesis of Nano structured magnetic materials has become a particularly important area of research and is attracting a growing interest because of the potential applications such materials have in ferro fluids, advanced magnetic materials, catalysts, colored pigments, high-density magnetic recording media, and medical diagnostics. Spinel ferrites (MFe_2O_4 ; M=Fe, Mn, Zn, or Co) are among the most important magnetic materials and have been widely used in electronic devices, information storage, magnetic resonance imaging (MRI), and drug-delivery technology. Magnetite (Fe_3O_4) has recently been considered an ideal candidate for biological applications, both as a tag for sensing and imaging, and as an activity agent for anti tumour therapy[4-5]. For high performance in function-specific biological applications, magnetic particles must be spherical and have smooth surfaces, narrow size distributions, large surface areas (for maximal protein or enzyme binding), high magnetic saturation to provide maximum signal, and good dispersion in liquid media.Literature reports show that reduction of particle sizes down to nano-size region causes drastic changes in saturation magnetization and magnetic anisotropy. Here we present novel synthesis of Nano-particle of $MnFe_2O_4$ with average size ~500Å.

Results and Discussion

Nano-particle samples of $MnFe_2O_4$ has been prepared following solvothermal process using $FeCl_3.6H_2O$ and $MnCl_2.4H_2O$. $MnCl_2{\cdot}4H_2O$ (0.50 g, 2.5 mmol) and $FeCl_3{\cdot}6H_2O$ (1.35 g, 5 mmol) were dissolved in ethylene glycol (40 mL) to form a clear solution, followed by the addition of NaAc (3.6 g) and polyethylene glycol (1.0 g). The mixture was stirred vigorously for 30 min and then sealed in a teflon- lined stainless-steel autoclave (50 mL capacity). The autoclave was heated to and maintained at 200^oC for 8h, and allowed to cool to room temperature. The products were washed several times with ethanol and dried at 60 ^oC for 6 h.

For crystalline characterization, Figure 1 shows the XRD patterns. The patterns confirm formation of single cubic phase with *a* ~8.385Å for $MnFe_2O_4$. Diffraction peaks are quite broad which is suggestive of small particle sizes. Average particle sizes, estimated using De-bye Scherrer equation are ~500 Å for $MnFe_2O_4$ sample. The crystallite size was estimated by the corresponding to major (311) peak reflections.

Figure 2 shows the TEM micrographs of the $MnFe_2O_4$ Nano powders. For TEM micrograph we take 100ml beaker fill with the acetone and mix the ~ 2 mg samples in the beaker. The sample was put for Ultra sonication for 30 minutes. After Ultra Sonication by using Micropipette we taken one drop and poured on the grid and dried for 15 minutes below the lamp. After that we taken TEM images As shown in Fig. 2. The sample consists of average ~50 nm nanoparticles.

The Photoluminescence (PL) Spectroscopy indicates that Large PL signals correlate with good interface properties.PL Intensity higher at 450 nm as shown figure 3.

By the UV/VIS Spectroscopy we found that the absorption spectrum of $MnFe_2O_4$ particles changes as concentration of solution changed. Absorbance at Concentration 1 is 328-430 nm and for Concentration 2 is 328-400nm As Shown in Figure 4.

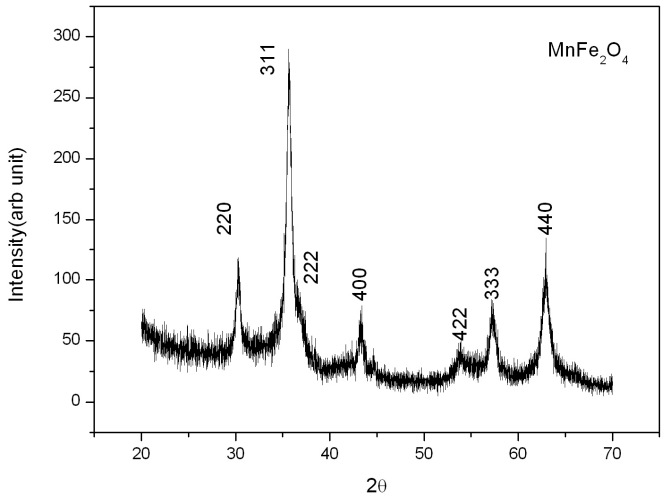

Fig:1- XRD pattern of $MnFe_2O_4$ using CuK_α radiation

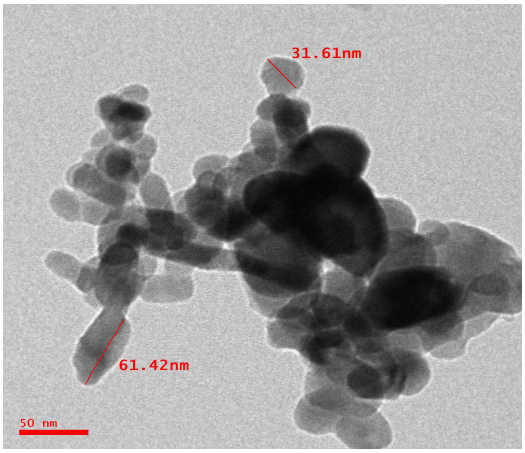

Fig. 2: TEM micrograph of $MnFe_2O_4$ Nanoparticles

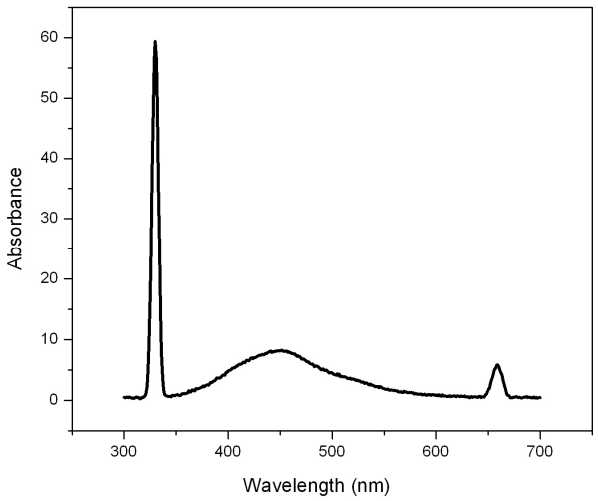

Fig:3- Photoluminescence (PL) of $MnFe_2O_4$

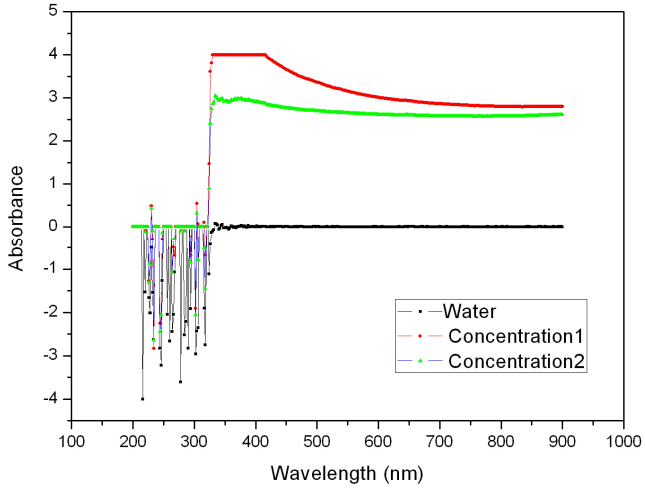

Fig.4:UV /VIS of $MnFe_2O_4$ Nanoparticles

Experimental details

The monodisperse $MnFe_2O_4$ Nanoparticles were prepared by a solvothermal reduction method The crystalline structure was characterized by X-ray powder diffraction (XRD). XRD pattern was recorded on PANalytical's X'Pert

PRO-PW3040 diffractometer with CuKα X-ray radiation (λ = 1.5406 Å). The morphology of the sample was recorded using TEM (Transmission Electron Microscope) FEI make Technai G2 S-Twin 200KV.

Conclusion

$MnFe_2O_4$ nanopowders was synthesized by Novel solvothermal method. Sample was characterized by X- ray diffraction, XRD results confirmed the formation $MnFe_2O_4$. The patterns confirm formation of single cubic phase with *a* ~8.385Å for $MnFe_2O_4$. Average particle sizes, estimated using De-bye Scherrer equation are ~500 Å for $MnFe_2O_4$ sample. The crystallite size was estimated by the corresponding to major (311) peak reflections. Transmission Electron Microscopy (TEM) are used for Morphological study, which indicates the Nano particle are well prepared. The Photoluminescence (PL) Spectroscopy indicates that Large PL signals correlate with good interface properties. The UV/VIS Spectroscopy Shows different absorption spectrum of $MnFe_2O_4$ particles at different concentration of solution.

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