

Facile and Low Cost Synthesis of Iron Oxide Nanoparticle by Precipitation Method

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Abstract

The aim of the study is to synthesis, characterization, optical properties and the types of bonding in iron oxide nanoparticles. The characterization was studied using XRD. The average grain size of the particle is studied using Scherer formula. The optical properties studied using UV-Vis and FT-IR spectra. The band gap energy of the iron oxide particle is 2.3eV.

Keyword: Iron Oxide, Nanoparticles, UV, XRD, FT-IR.

Introduction

Nano materials have accept significant attention due to their outstanding physico-chemical properties. Nano particles are sub-micron, made of inorganic and organic materials. Which have many novel properties. The preparation of Iron Oxide nanoparticles has attracted both fundamental and practical interest because interesting electronic, magnetic, catalytic and chemical or biological properties. Magnetic nanoparticles have many unique magnetic properties such as super paramagnetic, high coercivity, low Curie temperature, high magnetic susceptibility, etc. The ability to control the size, morphology and surface properties is very important because many of these applications depend on the properties. Magnetic nanoparticles are of great interest for researchers from a broad range of disciplines, including magnetic fluids, data storage, catalysis and bio applications. It is crucial to choose the material for construction of nanostructures material and device with adjustable physical and chemical properties. Iron oxides exist in a variety of structures and occur in a great variety of settings, from geological to nanoscale technological applications. Ferrous and ferric iron oxides present seven crystalline phase, the more common are α -Fe₂O₃(hematite), γ - Fe₂O₃ (maghemite), Fe₃O₄(magnetite) and Fe_{1-x}O (wustite); the less commonly found the β and ϵ - Fe₂O₃ phase and the low temperature rhombohedral structure of magnetite. Magnetic iron oxide nanoparticles consist of two major parts: preserved the magnetic property of magnetic iron oxides and preserved the other properties of iron oxides and preserved the other properties of organic molecules. Thanks to their fascinating properties, all of these oxides have been widely investigated by chemicals, engineers and physicists. These phase have been used successfully in many applications; e.g; magnetic nanoparticle have been used in a cancer diagnosis and therapy[1], drug delivery vehicles[2] and in water remediation[3]. Magnetic random - access memory devices[4]. Maghemite is used in magnetic resonance imaging [5], magnetic recording media [6], fabrication of biocompatible magnetic fluids [7], and electro chromatic devices[8], as cathodes in lithium batteries[9], and in the construction of photo electrochemical systems to produce hydrogen from water using solar radiation[10]. Various method have been developed to synthesize iron oxide nanoparticle such as precipitation method, sol-gel method, emulsion technique, Mono chemical processing, Hydro thermal precipitation and thermal plasma arc method. Recent advances in nanoscience and nanotechnology have also led to the development of drug delivery. The synthesis of highly-crystalline nanoparticle synthesized

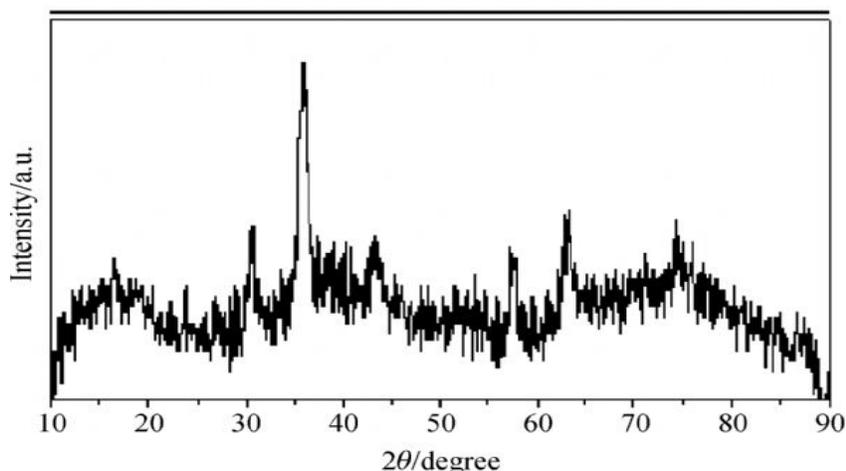
precipitation method. The samples were systematically characterized using XRD, the absorption spectra were investigated from UV-vis spectrometer and FT-IR.

Experimental

Materials and Method: Anhydrous Iron (III) chloride (FeCl_3) of 95% purity was obtained. The Iron (III) chloride was purchased with sd-fine. The Iron (III) chloride was stirred 25 minutes using water using precipitation method. The pH was adjusted to the 7-8. The stirrer compound is heated with 2.5 hours.

Result and discussion:

XRD-The XRD pattern of Iron Oxide nanoparticle is as shown in Fig:



The structural feature of Iron Oxide nanoparticles are explored from XRD data. The XRD pattern of Iron Oxide nanoparticle is as shown in fig. The XRD pattern showing $2\theta=24.14^\circ$, 33.14° , 35.61° , 40.84° , 49.45° , 54.06° , 62.42° , and 64.00° . The peaks found in the angle are labelled as (0,1,2), (1,0,4), (1,1,0), (1,1,3), (0,2,4), (1,1,6) planes. The geometry of the Iron Oxide nanoparticles found as per this XRD data corresponds to rhombohedra geometry. The average size of the synthesise were determined from the FWHM of the XRD peaks using Scherrer equation. The result of the calculation average grain size in nanometer. The breadth of the peak obtained by X-ray diffraction depends on the apparatus and crystallite size. For very small particle size (below 100nm) broadening from the apparatus is negligible and scherrer's formula permits calculation of the crystal size:

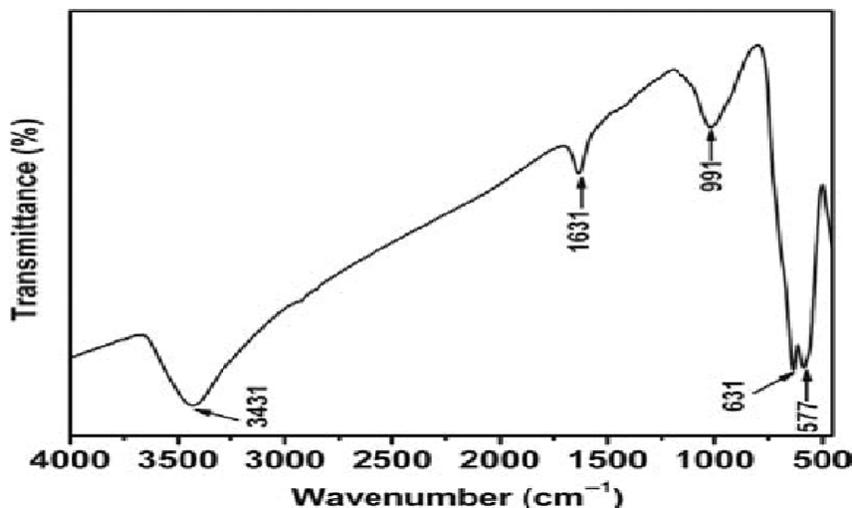
$$DRX=0.9\lambda/ \Delta\cos\theta$$

Where 0.9 is a dimension constant of the equipment, λ is the wavelength of radiation corresponding of the Cu $K\alpha$, peak and θ is the Bragg's angle. The grain size of the particle is 80-90 nano meter.

Fourier Transform Infrared Spectroscopy

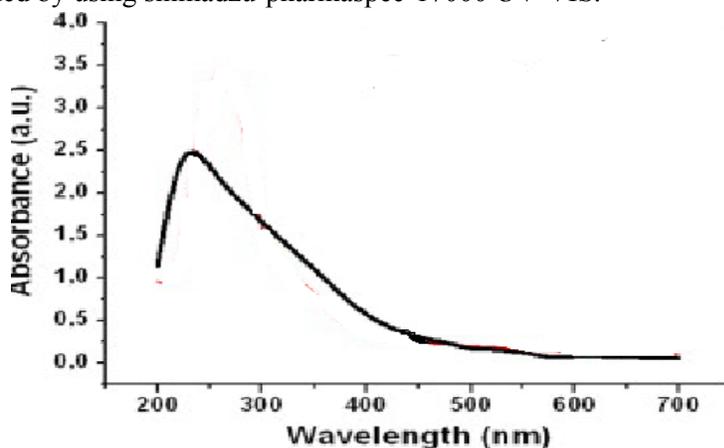
The nanoparticle powder sample was mixed with KBr powder and ground into fine powders. The powders were pressed into pellets at 15000 psi. The solution sample was measured using a thin-layer (0.5mm) IR cell. The IR spectra were collected over the range of $400-4000\text{cm}^{-1}$

The strong band at 552cm^{-1} may resulted from (O-H) stretching vibration. The infrared portion of the electromagnetic spectrum divided in three regions: near, middle and far infrared named for the visible spectrum. In fig 1700- 3600 C=O stretching.



Optical Properties Synthesis Fe₂O₃ Nanoparticles:

Optical properties of Fe₂O₃ sample were determined through UV-VIS. The optical absorption spectra was recorded by using shimadzu-pharmaspec-17000 UV-VIS.



Optical absorption coefficient has been calculated in the wavelength region 200-900nm. The band gap of the as prepared nanoparticles are determined from the relation $(\alpha h\nu)^2 = C(h\nu - E_g)$. The presence of absorption maximum at 272nm in the UV-vis spectrum.

Conclusion

The nanoparticle formed from slow titration of FeCl₃ with aqueous have controlled growth and controlled crystal structure depend on the temperature of the synthesis. The XRD analysis demonstrate the nanoparticle have the hexagonal Rhombohedral structure. The UV-Vis and FT-IR spectrum was taken and characterization was studied. The band gap energy of the iron oxide nanoparticle is 2.3 eV.

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