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Synthesis and Characterization of Iron Oxide Nanoparticle by Precipitation Method

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Abstract: *The nano iron oxides have been synthesized by all most all the known simple precipitation method. The aim of the paper is grain size, optical properties and the types of bonding calculated. 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: *Nanoparticle, Iron Oxide, XRD, FT-IR, UV.*

1. INTRODUCTION

Nanosize materials have accept significant attention due to their outstanding physic-chemical properties. Nanoparticles are sub-micron moieties (diameter ranging from 1-100 nm according to the used term, although there are examples of nanoparticles several hundred of nanometer in size) made of inorganic and organic materials, which have many novel properties compared with bulk materials. The properties of nanoparticle can significantly altered by surface modification. The preparation of Iron Oxide nanoparticles has attracted both fundamental and practical interest because interesting electronic, magnetic, catalytic and chemical or biological properties .On the basis, 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. Currently, magnetic nanoparticles are also used in important bioapplication, including bioseparation and detection of biological entities (cell, protein, nucleic acids, enzyme, bacterial, virus, etc.), clinic diagnosis and bioseparation and detection of biological labels. However, 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-Fe_2O_3(hematite),γ-Fe_2O_3(maghemite), Fe_3O_4(magnetite) and $Fe_{1-x}O$(wustite); the less commonly found the β and ε-Fe_2O_3 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]. Maghmite 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].

Varies 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. In this article synthesize of highly crystalline α-Fe_2O_3 nanoparticles synthesized by precipitation 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 sample were systematically characterized using **XRD,** the absorption spectra were investigated from **UV-**vis spectrometer. and **FT-IR.**

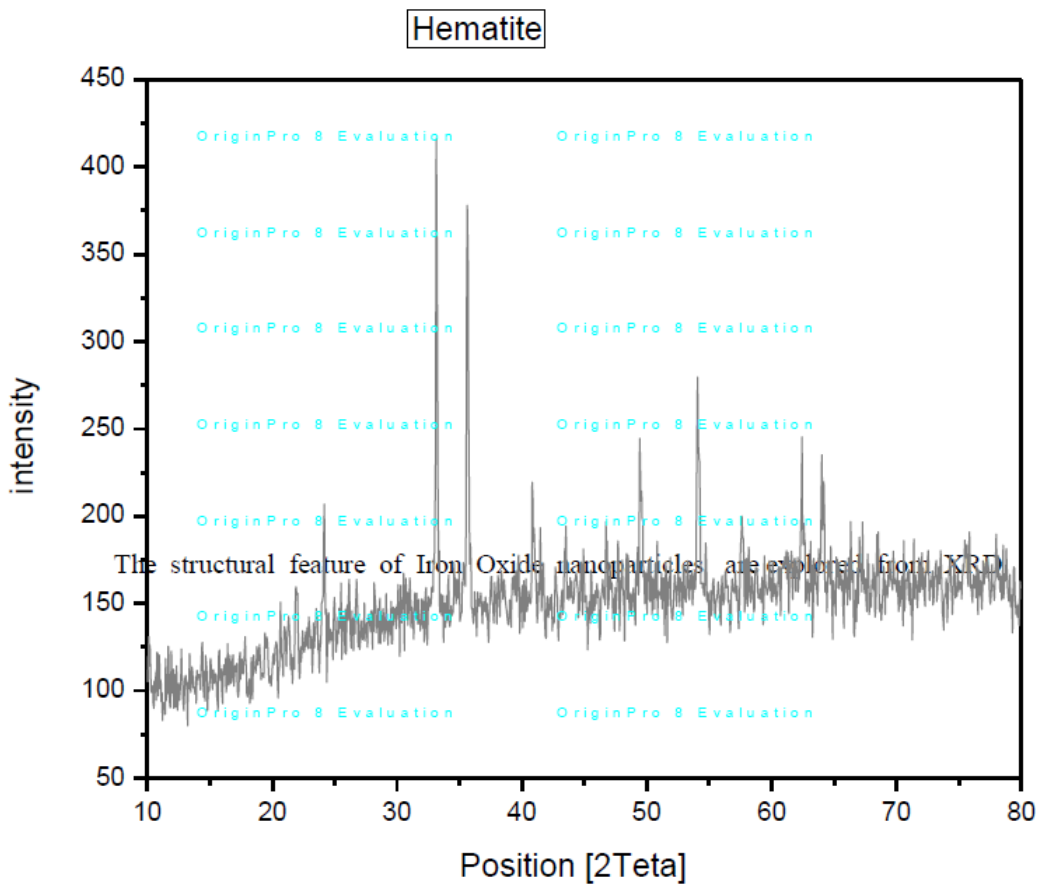
2. Experimental

2.1. Materials and Methods

Anhydrous Iron(III) chloride ($Fecl_3$) of 96% purity was obtained from Mumbai and distilled water were used . The Iron(III) chloride was purchased with Merk and used as received. The Iron(III) chloride was stirred 30 minutes using water using precipitation method. The pH was adjusted to the 7-8. The stirrer compound is heated with 3 hours using hot plate.

3. Result And Discussion

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 $2\theta=24.14^0$, 33.14^0, 35.61^0, 40.84^0, 49.45^0, 54.06^0, 62.42^0, and 64.00^0. The peaks found in the angle are lapelled as (0,1,2), (1,0,4), (1,1,0), (1,1,3), (0,2,4),(1,1,6) planes per the JCPDS.NO.89-8104 file. The geometry of the Iron Oxide nanoparticles found as per this XRD data corresponds to rhombohedra geometry. The average size of the synthesize were determined from the FWHM of the XRD peaks using Scherrer equation. The result of the calculation average grain size in nanometer.

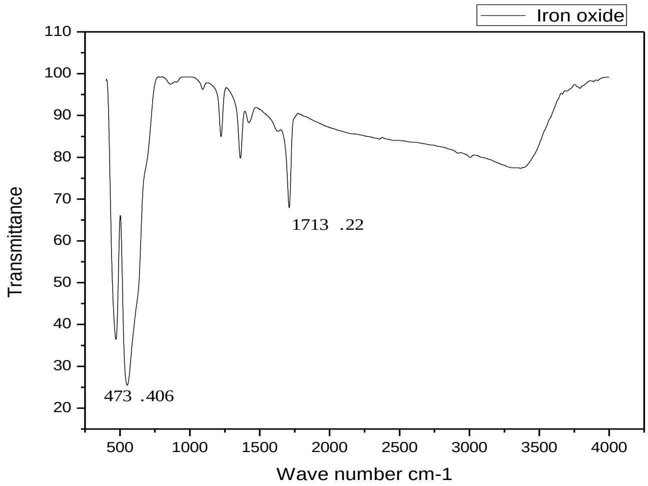
The breadth of the peak obtained by X-ray diffraction depends on the apparatus and crystallite size. For very small particle size (below 100nm) broadening from the apparatus is negligible and scherrer's formula permits calculation of the crystal size:

3.1. $D_{RX}=0.9\lambda/\Delta\cos\theta$

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

3.2. Fourier Transform Infrared Spectroscopy

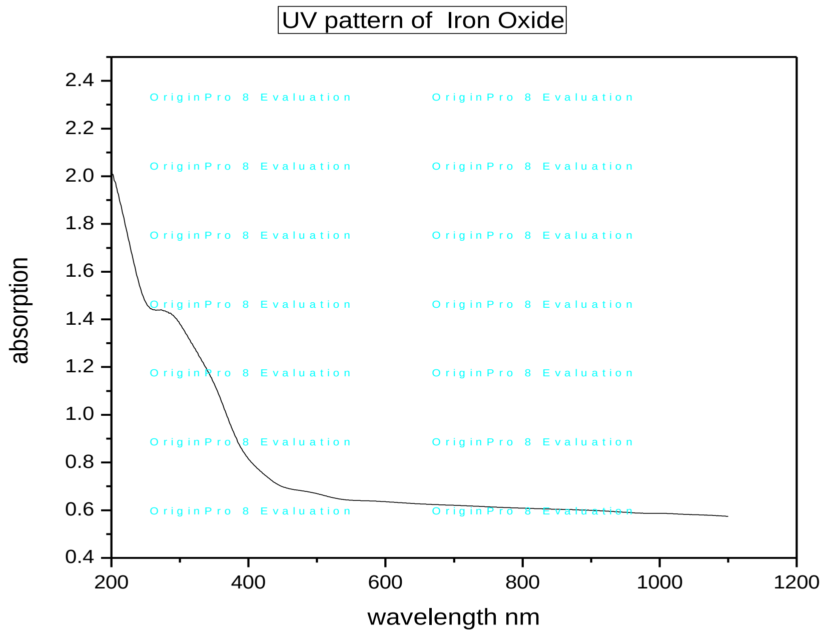
Infrared spectra were acquired with a Nicolet 760ESP FT-IR spectrometer that was purged with boil-off from liquid N2. The spectrometer was equipped with a liquid nitrogen-cooled HgCdTe detector. The nanoparticle powder sample was mixed with KBr powder and ground into fine powders. The powders were pressed into pellets at 15000psi. The solution sample was measured using a thin-layer (0.5mm) IR cell. The IR spectra were collected over the range of 400-4000cm^{-1}.



The IR spectrum of Iron Oxide nanoparticles manifests prominent absorption band located at 3789,3365,30005,1710,1422,1361,1223,1092,862,552 and 471cm^{-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.

3.3. Optical Properties Synthesis Fe_2O_3 Nanoparticles:

Optical properties of Fe_2O_3 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

$(\alpha h\gamma)^2=C(h\gamma-E_g)$

Where, C is a constant, E_g is the band gap of the material. α is the absorption co-efficient. The presence of absorption maximum at 272nm in the UV-vis spectrum.

4. Conclusion

The precipitation synthesis of iron oxide nanoparticle is high concentration of starting material. 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 Rhomohedral 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. The

References

[1] L.D. Marks. Rep. Prog. Phys. 57 (1994) 603-649.

[2] B. Chertok, B.A. Moffat, A.E. David, F. Yu, C. Bergemann, B.D. Ross, V.C. Yang. Biomaterials. 29 (2008) 487-496.

[3] C.T. Yavuz, et al. Science. 314 (2006) 964-967.

[4] S. Soeya, J. Hayakawa, H. Takahashi, K. Ito, C. Yamamoto, A. Kida, H. Asano, M. Matsui. Appl. Phys. Lett. 80 (2002) 823-825.

[5] D. Fiorani, A. M. Testa, F. Lucari, F. D’Orazio, H. Romero. Physica B 320 (2002) 122-126.

[6] H. Itoh, T. Sugimoto. J. Colloid Interface Sci. 265 (2003) 283–295.

[7] M. H. Sousa, J. C. Rubim, P. G. Sobrinho and F. A. Tourinho. J. Magn. Magn. Mater. 225 (2001) 67-72.

[8] Z. Wang, X. Hu, P. Kall, U. Helmersson. Chem. Mater. 13 (2001) 1976-1983.

[9] D. Larcher, C. Masquelier, D. Bonnin, Y. Chabre, V. Masson, J.-B. Leriche, J.-M. Tarascona. J. Electrochem. Soc. 150 (2003) A133-A139.

[10] E.L. Miller, D. Paluselli, B. Marsen, R.E. Rocheleau. Solar Energy Mater. Solar Cells.88 (2005) 131–144.