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SYNTHESIS AND CHARACTERIZATION OF HEMATITE NANO PARTICLES BY THE METHOD OF CHEMICAL PRECIPITATION

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ABSTRACT

Oxide magnetic nano materials finds its applications in various fields such as drug delivery, iron industries, biomedical applications etc. In the present work, hematite nano particles were synthesized by the chemical precipitation method. The Nano materials thus prepared were characterized by adopting various techniques like PXRD, FTIR, and UV. The average particle size calculated using Debye-Scherrer formula is found as 8.8 nm. The formation of the hematite nanoparticle is confirmed by FTIR spectroscopy. The optical band gap for the prepared nano materials is obtained from the UV-spectra.

KEY WORDS: Hematite, chemical precipitation, PXRD, FTIR, UV.

INTRODUCTION

Nano science is one of the most important researches in modern science. The use of nanoparticle materials offers major advantages due to their unique size and physico chemical properties [1-3]. Real uses of nanostructured materials in life sciences are uncommon at the present time. However, the excellent properties of these materials provide a very promising future for their, use in this field [4-7] . Industrial applications of magnetic nanoparticles cover a broad spectrum of magnetic recording media and biomedical applications. [8,9]. Nowadays nanotechnology is very important for the advancement of science, since it makes use of the manipulation of matter on a scale in which materials show different characteristics than those displayed in the micro and macro scale. In nanoscale, phenomena of finite size and surface effects startto dominate the magnetic behaviour of individual nanoparticles [10]. Magnetic materials, especially iron oxide nanoparticles, are known since ancient time to have many spectacular properties, but in the last decade the properties that they posses at nanometric scale have been the starting point of great potential applications such as drug delivery, magnetic cell separation, tumour labelling and cell labelling [11]. In nanotechnology, an iron oxide nanoparticle is defined as a small objects that behaves as a whole unit in terms of its transport and properties. Particles are further classified according to size, in terms of diameter, fine particles cover a range between 100 and 2500 nanometers [12]. Iron oxide based nanoparticles belong to the most widely used materials in this field although they have worse magnetic properties, lower saturation magnetization, and lower specific loss of power than Fe and CO nanoparticles which have just started to gain attention for biomedical purposes [13]. Iron oxide magnetic nanoparticles differ with their atoms and bulk counter parts in their physical and chemical properties [14]. The iron oxide exists in nature in different forms. Magnetite, maghemite, and hematite are the most common among them. Maghemite and magnetite, contain single domains of about 5-20 nm in diameter [15].

SYNTHESIS AND CHATRACTERIZATION

Materials and Methods

Iron oxide nanoparticles were synthesised by adopting the method of chemical precipitation. Here an aqueous solution of iron oxide was prepared by dissolving iron (lll) chloride hexahydrate in distilled water for 0.05 M concentration. This aqueous solution was heated continuously for 30 min under magnetic stirring, maintaining a temperature of 80^0C. An aqueous solution of 2M of NH_4OH was used as the precipitating agent. Base solution (NH_4OH) was added gradually drop wise to maintain a pH value 11. The reaction vessel was heated up to the temperature of 80^0C under magnetic stirring for 3 hours. The resulting precipitate is centrifuged at 5000 rpm and then washed with distilled water and ethanol for several times and finally dried in air and calcined at 700^0C for 2 hours.

RESULTS AND DISCUSSION:

Structural Analysis

The structural features of the prepared haematite nano particles are explored from XRD spectra. The XRD pattern of the prepared haematite nano particle is shown in fig 1. The XRD pattern shows several significant peaks corresponding to the intensities 32. 73, 35.20, 40.45, 49.05, 53.64, 62.01, 63.54, 71.58 as (104), (110), (113), (024), (116), (214), (300) and (208) respectively.. All the peaks can be perfectly indexed to rhombohedral structure of Fe_2O_3. (JCPDS NO. 24.0072). The average size of the particle is found to be as 8.8 nm, from the Scherrer equation

$$D = \frac{0.9\,\lambda}{\beta cos\theta}.$$

Where

λ- X-ray wavelength

β- The full width at half maximum of the diffraction peak

θ- The Bragg diffraction angle in degree

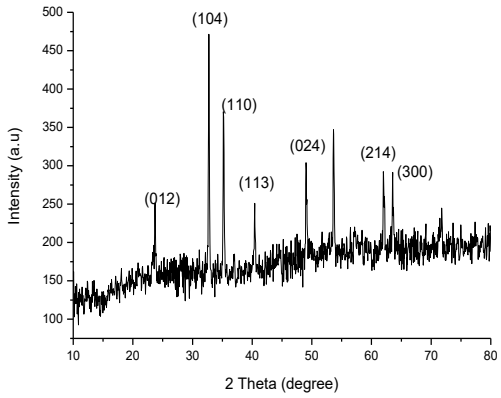

Fig:1 The XRD pattern of the prepared haematite nano particle

Optical Analysis

Optical properties of Fe_2O_3 sample were determined through UV-VIS. Optical absorption coefficient has been calculated in the wave length region 200-400 nm. The band gap of the prepared nano particles are determined from the Davis-Mott equation Eg= hc/λ [17].

Where, Eg - Energy gap
C - Velocity of light
λ-Wavenumber

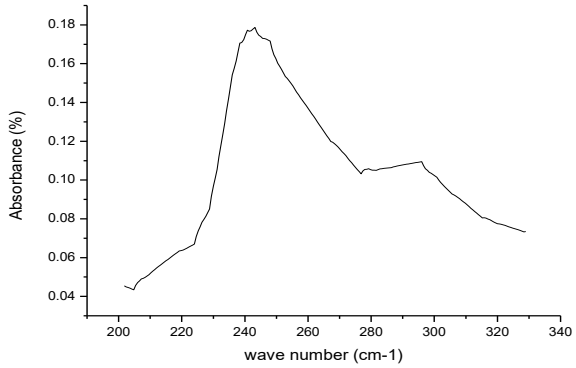

Fig:2 The UV-Visible spectra of the prepared hematite nano particle

FTIR Analysis

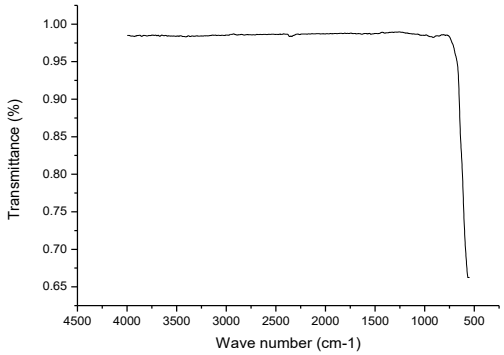

Fig.3 FT-IR spectra of the prepared hematite nanoparticle

Fig:3 shows the FTIR spectra of the prepared hematite nanoparticle. From fig, it clearly reveals that there exists no significant impurity peaks. The strong absorption peak at 551 cm^{-1} is assigned to be the Fe-O vibration band. Since there are no impurity peaks, it is found that this method of preparation is an opt method for the preparation of hematite nano particle.

CONCLUSION

The Haematite (Fe_2O_3) nano particles were successfully synthesized by adopting the method of chemical precipitation. The prepared Fe_2O_3 particles were characterized by using XRD, FTIR, and UV analysis. XRD confirms the rhombohedral structure of Fe_2O_3 having a particle size of 8.8nm. FTIR analysis has confirmed the presence of Fe_2O_3. The optical band gap of the prepared hematite particle is 4.4 eV.

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