Preparation of Maghemite γ -Fe_2O_3 Nanoparticles by Electrochemical Method

Shaimaa Hussien Shahad
University of Wasit / College of Science / Department of Physics

المستخلص

تم تحضير طور كاما- اوكسيد الحديد (**γ -Fe_2O_3**) بطريقة الخلية الكهروكيميائية باستخدام صفيحة مستطيلة من الحديد كقطب انود وقضيب من الكرافيت كقطب كاثود. تم تشخيص هذه الجسيمات النانوية باستخدام عدة تقنيات وهي حيود الاشعة السينية والمجهر الالكتروني الماسح والمجهر الالكتروني النافذ.

من خلال النتائج تبين ان الجسيمات النانوية ذات شكل رباعي مع معدل حجم حبيبي 17 نانومتر كما ان سطح الجسيمات النانوية يكون مسامي ذات بلورات جيدة.

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Abstract

Fe_2O_3 nanoparticles were synthesized by electrochemical method using a rectangular iron plate as an anode and Graphite rod as the counter electrode cathode. The synthesized nanoparticles were examined by transmission electron microscopy (TEM), scanning electron microscopy (SEM) and X-ray diffraction (XRD). Results show that nanoparticles have tetragonal shape with average size of 17 nm. The surface of nanoparticles is smooth with good crystallinity.

Keywords: Nanoparticles, iron oxide, electrochemical method, maghmite

Introduction

Nanoparticles are zero dimensional because all the dimension are measured inside the nanoscale (under 100 nm). It shows anew and fascinating properties that rely upon the size (diminishing size from full scale and miniaturized scale to nanoscale). Nanoparticles are broadly present in the natural world as photochemical responses, because of volcanic action or delivered by plants or green growth. Nanoparticles have likewise been made, accidentally, by people as results of burning buildups and cooked nourishment or, all the more as of late, as the remaining parts of the depleted fuel of vehicles [1]. In contrast with the amount of nanoparticles delivered normally or inadvertently, nanoparticles combined for investigation or mechanical

intentions are a little minority. Press oxide nanoparticles are one of the critical oxides, which has a large portion of utilizations because of its non-poisonous quality [2-11].

EXPERIMENTAL

All chemicals were used without any purification.

Maghemite γ -fe_2O_3 nanoparticles were synthesized by electrolysis, using 120 ml of 0.02 M NaOH at 27 °C as electrolyte. A rectangular iron plate (4 cm x 2 cm x 0.1 cm) was used as an anode. Graphite rod (0.5 x 5 cm) was used as the counter electrode cathode. Before mounting the substrates in the cell, they were cleaned sonically using aqueous and organic cleaner Solvents (ethanol, chloroform, de-ionized water) sequentially. Each step of cleaning lasted for 10 minutes. The applied DC voltage between the electrodes was 6V under current density of 5.43 $x10^{-3}$ mA\cm^2 for 1 h. A red-brown magnetic precipitate was obtained. The product was separated and washed with de-ionized water and dried over night to subsequent analysis [12].

The electro deposition reaction pathway to form ɣ- Fe_2O_3:-

$Fe \rightarrow Fe^{+3} + 3e^-$

$Fe^{+3} + 3OH^- \rightarrow Fe(OH)_{3(aq)}$

$2Fe(OH)_3 \rightarrow 2\ FeOOH + 2H_2O$

$2\ FeOOH \rightarrow$ ɣ- $Fe_2O_3 + H_2O$

(all of them at PH = 13)

Results and discussion

The morphological and structural of synthesized different phases iron oxides nanoparticles were examined by various techniques.

The structure of the various modified samples was investigated by XRD use (Cu Kα radiation line of wavelength of 1.54 ˚A in 2θ range from 10◦ to 80˚.The patterns of the phases of iron oxides nanoparticles was shown in Figure (1).

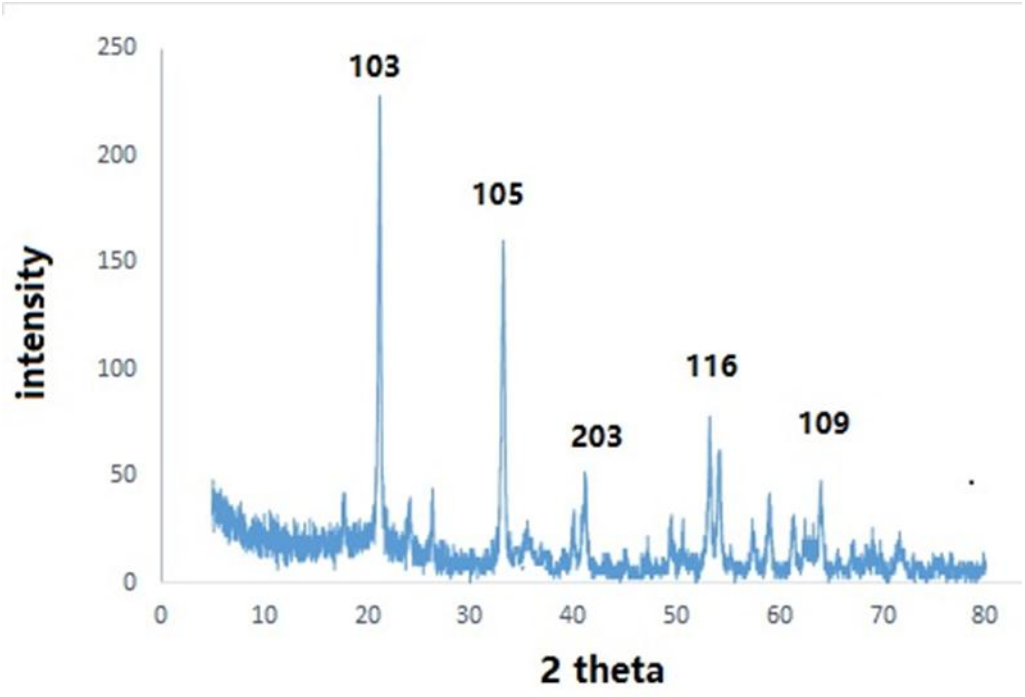

Fig (1) XRD pattern of ɣ-Fe_2O_3 Np_s (maghemite)

The XRD pattern shows a significant amount of broadening lines, which are characteristic of nanoparticles. The crystal size can be calculated according to Debye-Scherrer formula [13].

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

Where k=0. 9, Scherrer constant, λ is the wavelength of the Cu-Kα radiations, β is the full width at half maximum, and θ is the angle obtained from 2θ values corresponding to maximum intensity peak in XRD pattern. The calculated means crystal size of nanoparticles was 17 nm.

The morphology and particles size were determined by TEM. The mean particle size and distribution were determined randomly on the TEM image; fig (2). The mean particles size was 17 nm.

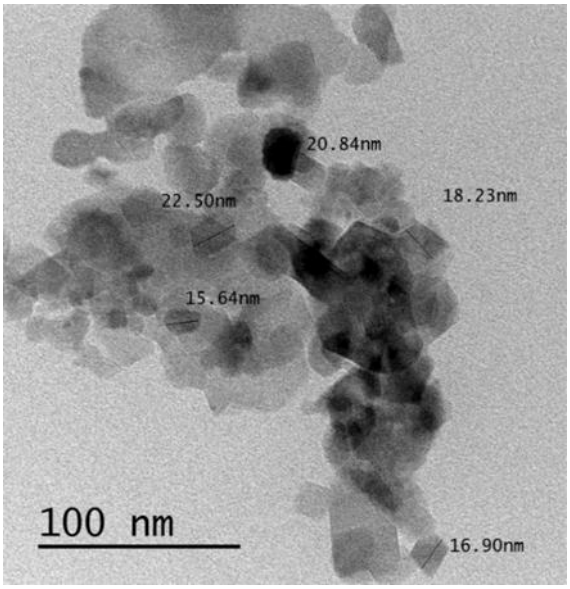

Fig.2 TEM images of ɣ-Fe_2O_3 NPs (maghemite)

SEM images, Fig (3) shows the morphology and size distribution of different phases iron oxide nanoparticles. The surface of nanoparticles is smooth with good crystallinity. The average particle size and distribution were determined randomly on the SEM images. It is about 20 nm.

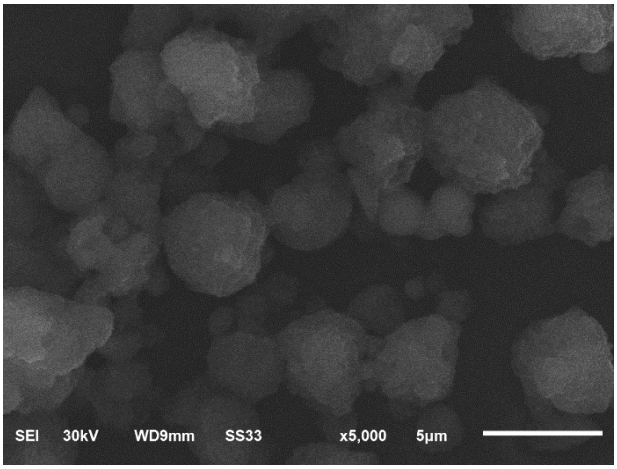

Fig (3) SEM images of ɣ-Fe_2O_3 NPs (maghemite)

Conclusion

Maghemite Y- Fe_2O_3 nanoparticles was synthesized by electrolysis method. The morphological, structural and optical roerties of synthesized Y- Fe_2O_3 nanoparticles was examined by X-ray diffraction (XRD), transmission electron microscope (TEM) and scanning electron microscope (SEM). The surface of nanoparticles is smooth with good crystallite.

The gamma iron oxide nano particles has uniform tetragonal shape with an average size of 27 nm.

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