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Synthesis and Characterization of Silica Nanoparticle (Sio_2 Nps) Via Chemical Process

Ayad Hatim Karim[*1a], AqeelAbdUljaleel Ali[2a], SalimOudah Mezan[3b]

[1,2a]*Ministery of Education General Directorate of Education in Al-Diwaniyah Governorate, Republic of Iraq*
[3b]*General Directorate of Education in Al-Muthanna Governorate, Ministry of Education, Republic of Iraq*
*Email corresponding**:ayadnona17@gmail.com

Abstract

An economical and environmentally friendly method for preparing silica nanoparticles has been proposed. Use sol-gel with ultrasound to prepare SiO2 NPs at the temperature of 400 °C and a time of 1 hour. Silica particles were obtained by hydrolysis of tetraethyl silicate (TEOS) in ethanol medium and a detailed analysis of the effect of particle sizes was performed. Different sized particles were synthesized in the range of 30 nm. Scanning electron microscopy, Atomic Force Microscopy (AFM) and was applied to study particle size. The influence of the temperature on particle size has been studied possibly used in drug delivery, supercapacity and Used as an electrically insulating material in nanoelectrical. The results obtained in this study are in line with the results found by literature studies.

Keywords: nanomaterial, nanoparticles, Silica, sol-gel, temperature.

1. Introduction

In contrast to their bulk counterparts, nanomaterial's can exhibit radically different and remarkable physical, chemical, optical and electrical properties[1]. Furthermore, in the nanoscale regime (<100 nm), unique phenomena such as quantum effects begin to occur[2]. Semiconductor effects are of intense interest industries and electronics, where nanotechnology provides smaller and more accurate manufacturing techniques[3][4]. It can enhance conductive and mechanical properties by doping and applying small quantities of nanomaterial's to bulk plastics and fibres, pushing the limits of synthetic materials[5]. With commercial applications in the electronics, energy and biomedical industries expected to reach USD 100 billion globally in 2020; nanotechnology is no longer a distant vision[4].

Silica nanoparticles extracted of natural resources contain metal impurities including aren't conducive to advanced scientific including industrial uses[6]. Thus, the focus is about synthetic SiO_2 (SiO_2 colloidal, SiO_2 gel, pyrotechnic SiO_2, precipitated SiO_2), which is true also is manufactured chiefly in amorphous powder forms compared to natural mineral SiO_2 (quartz, trade, cristobalite)[7].Silica-based nanoparticle are solid inorganic matters with a big surface area, a 3D structure by very open spaces that are interconnected[8]. Due into its promising properties such as high-grade biocompatibility, non-toxicity, thermal stability, the active electron into the

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water medium also the suitability of many surface freeze mechanisms, silica-based NPs are the preferred substrate for many applications. Nanotechnology has contributed significantly to medical, biological, pharmaceutical, food, agricultural science and a wide range of fields have been developed. Engineering[9]. It is the manufacture of usable goods, tools,manipulation of matter on the nanometer scale and manipulation of novel phenomena and properties resulting from the nanometer scale by means of systems.Therefore, it is possible to design the necessary materials[10].

Via the influence of the above variables, optical, magnetic, elastic and chemical properties. Nanoparticles of scattered, amorphous and uniform silica due to their easy planning and possible applications in different industries, they have aroused particular interest[11]. In a varied cement method, it can be used as efficient materials to improve strength, flexibility, durability, workability, etc.[12].

1.1 Nanoscale Silica

Nanoscale technology is a nanotechnology branch in which standard size instruments are used to create simple constructions, including devices with measurements in the order of a few nanometers or less, where one nanometer (1 nm) [13] is (10^{-9} m) shown in Figure1[14]. Nanoscale technology covers all of the nanotechnologies except molecular processing. Nanotechnology has possible advantages in a number from areas, sanitation, including water purification, agriculture, renewable energy (particularly photovoltaic), home and communications, business construction, medicine, and computer manufacturing[15].

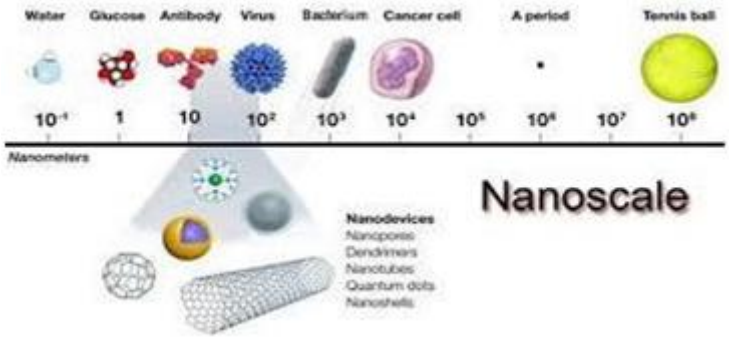

Fig.1.nanoscale of material

One of the most commonly used and manufactured engineered nanomaterial's is nanoscale silica[16]. There are different techniques, as well as small-scale laboratory syntheses, for its large-scale preparation and processing. Their tunable size, density and porosity, as nanoparticles, have led to intense interest and their use as platforms for drug delivery[17]. In addition, silicon dioxide (SiO_2) is used commonly as a Coating for organic and inorganic nanoparticles, providing aqueous media with colloidal stability, chemical inertness, optical clarity and a simple surface chemistry platform [18]. While nanoparticles of silica are often considered biocompatible and because of contradictory findings, their "well-tolerated" cytotoxicity is subject to ongoing research and investigation [19].

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It has also been shown that cytotoxicity is controlled by particle size, surface charge and degree of porosity. Nano-silica has the desirable characteristics needed in bioapplications, although its toxicity is not entirely clear [20]. They are biodegradable alongside their previously mentioned strengths and their circulation characteristics can be easily tuned and regulated [22]. The method described in this paper, which prepares monodisperse silica nanoparticles from silica precursors, aqueous alcohol solution, and base catalyst, is the most common method for synthesis (ammonia). Particle size is controlled by the ratio of the precursor to the catalyst, from several micrometres to tens of nanometers [23].

2.Synthesis of silica(SiO_2) nanoparticles via Sol-Gel Method

The sol-gel method does commonly utilized as a dissolution into manufacture SiO2, ceramic also glass materials due to its ability to produce pure also homogeneous production at mild condensation. This method requires hydrolysis including an intensification from mineral alkoxides ($Si(OR)_4$) such as tetraethylorthosilicate (TEOS, $Si(OC_2H_5)_4$) or inorganic salts such as sodium silicate (Na_2SiO_3) in the presence of metal acid or base in the presence of metal acid (e.g., HCl) or base by various actions on the synthesis of polymer SiO_2. A similar percentage-weighing blend of tetraethylorthosilicate (TEOS) including ethanol did initially synthesis. The $CaCl_2$solution thereafter also HCl. The pH was continued to be set wherever the SiO_2 precursor's average hydrolysis is sufficiently high to complete hydrolysis within1 hour at 400ºC. Next hydrolysis, NH_4OH was applied to the pace intensification response main at gelation in the neuter case as an intensification catalyst. The mole levels of TEOS to distilled water did 1:5, HCl on TEOS was 500:1, ethanol to TEOS was 1:5.6 plus TEOS to NH_4OH was 1:90. In the final solutions, the model $CaCl_2$ concentricity ranged from. After a gel is collected, it is placed in a centrifuge 5000 (rpm) and thoroughly washed with ethanol and water to purify it from impuritiesafter that, a get 2.8gm. Shown into Figure 2.

Fig.2. The procedure for the synthesisfrom drug loaded silica aerogels

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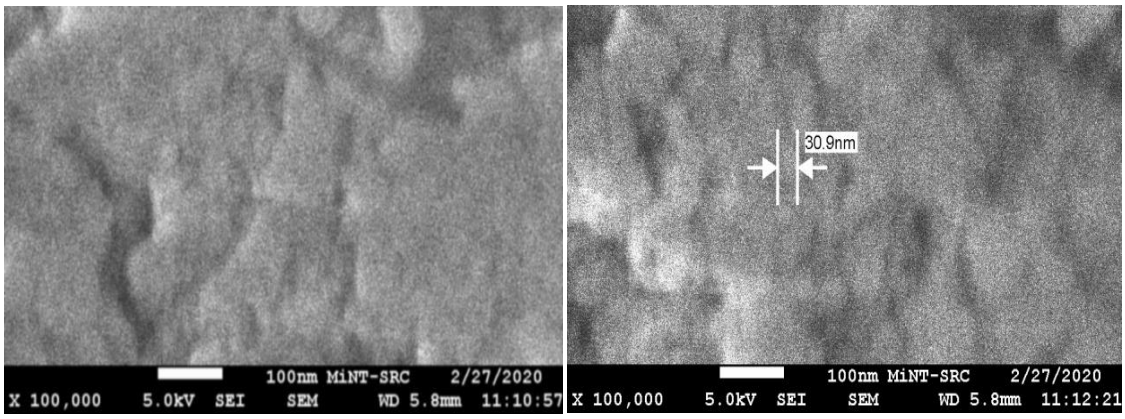
3.Result and discussion

3.1 Scanning electron microscopy (SEM)



a b

Fig. 3 FESEM images of SiO_2NPs

Particle sizes, shape and morphology were measured using field emission scanning electron microscopy (FESEM JEOL JSM-7600F- SM17600053, Japan) equipped with OXFORD X-MAX.). A drop of dilute and well sonicated colloidal silica solution was placed on a carbon-coated copper grid. For the FESEM, a Powder of the sample was placed on copper tape pasted on a holder, the solvent was evaporated and the particles were coated with ~10 ºAthin gold layers before examining in FESEM. The particle size was estimated using analysis image processing software. The (FESEM) was applied to examine the surface morphology of the SiO_2 nanoparticle he results is shown in Figures 3. The homogeneous and smooth surface and larger diameter were achieved at SiO_2. It's clearly observed from the Figure 3 that the average diameter of SiO_2 is 30 nm from

3.2 Atomic Force Microscopy (AFM)

The surface topography and roughness from SiO2 nanoparticle was investigated using Atomic Force Microscopy (AFM). The AFM images from the silica nanoparticle powder do shown into Fig 4.(a-b). SiO_2 shows uniform distribution and uniform dispersion and the smooth surface morphology of films are clearly shown from AFM images. The average grain size, root mean square and roughness are estimated and tabulated in Table 1. The SiO_2 nanoparticle films, respectively. The increased in surface roughness of silicananoparticle will enhance light absorption in photodetector applications.Fig. 4(a-b) reflects an analysis of the roughness of each thin film in the(Nanoscope Analysis 1.7 method performed in the program, and the Image J program)is applied to translate received data into the image also to conduct different analyses that satisfy the demands of a consumer. By measuring the roughness parameters Ra, Rq and maximum elevation, surface roughness was defined. Transparent surface roughness has a major impact on the efficiency of the system. By analyzing the topographic scans of the sample's surface, the roughness parameters are calculated. The surface profile parameters include average roughness (Ra), root means

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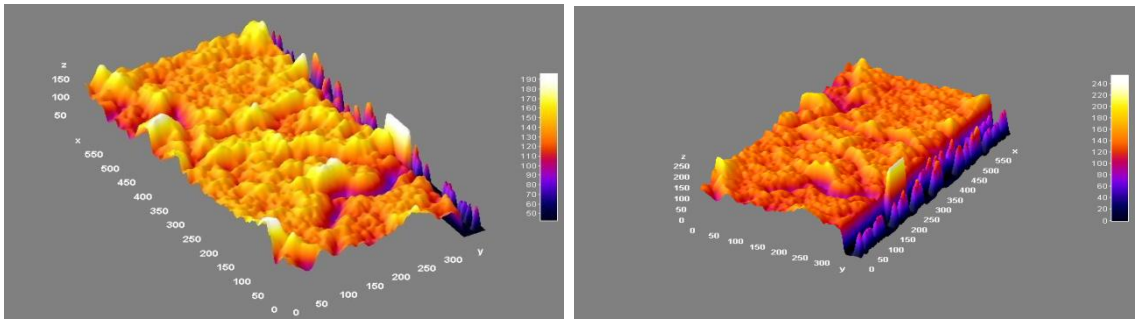
square roughness(R_q), maximum peak to valley height(R_t), ten-point average roughness(R_z), skewness of the line(R_{sk}), kurtosis of the line(R_{ku}).

Table1.Statistical parameters for the SiO_2 nanoparticle

Statistical	R_a nm	RMS R_q (nm)	R_t nm	R_z nm	Skewness R_{sk}	Kurtosis R_{ku}
SiO_2	35.6	48.3	56.19	165.06	0.35	3.20



a b

Fig.4.AFM images obtained for (a, b) SiO_2

3.3 Silica (SiO_2) nanoparticles elemental composition analysis(EDS)

Energy-dispersive X-ray spectroscopy did apply to analyze the elemental composition from the synthesized SiO_2 nanoparticles (EDS). Qualitative also quantitative information on the elemental silicon plus oxygen involved in the production from silica (SiO_2) NPs is given in the EDS review. Figure 4. (a-b) displays the EDS continuums including the results are tabulated in the Table. 2. The carbon, oxygen and silicon elements are detected and their corresponding weight and atomic percentage are shown in Table 2 to their location. A present from the carbon in Figure 4 and Table 2. (b) is due to the burning result.

Table 2.Elemental composition of SiO_2 nanoparticle

Element	Weight%	Atomic%
O	4.33	7.19
C	51.76	60.48
Si	43.91	32.34

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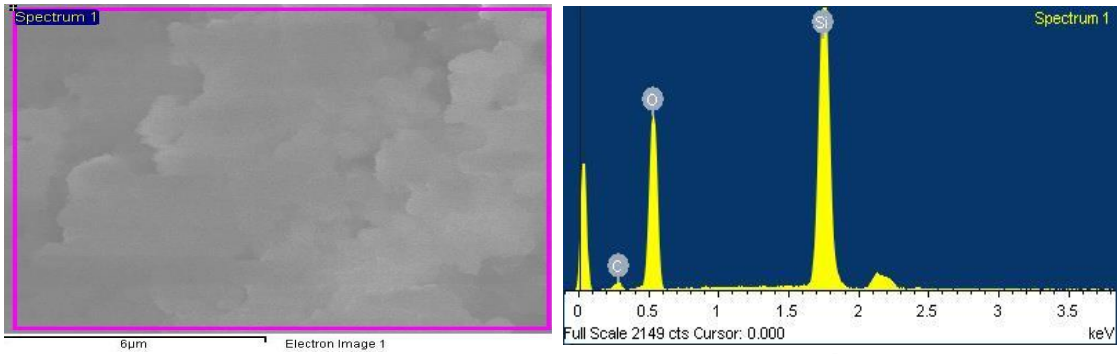

a b

Fig.5. EDS spectrum of (a and b) SiO_2

4.Conclusion

Use sol-gel with ultrasound to prepare silica nanoparticles the way hydrolysis of tetraethyl orthosilicate (TEOS), at a temperature of 400 ° C and a time of 1 hour. Atomic force microscopy (AFM) was employed to monitor surface morphologies. The AFM topography of annealed films in 400 ºC showed that the film surface is having waviness surface. Where the film surface exhibits a higher roughness and use EDS the carbon, oxygen and silicon elements are detected and their corresponding weight and atomic percentage.Where it can be applied in the fields of medicine in drugs delivery, supercapacitorsandUsed as an electrically insulating material in nanoelectrical.

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