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Titanium Dioxide Nanoparticles Synthesis by Pulsed Laser Ablation

Sarah Adnan , Ziad T. Al-dahan , Eman Ghadhban
Biomedical Engineering Department-College of Engineering-Al-Nahrain University- Baghdad- Iraq
Corresponding Author; Sarah Adnan

----------***ABSTRACT***----------
A Q-switched *Nd:YAG* laser is used *to synthesize TiO_2 nanoparticles.Pulsed laser ablation in liquids (PLAL) has been confirmed as a fast and simple method for synthesizing TiO_2 nanoparticles, technique has fascinated much rising interest. It has been well-known as a simple, quick, uncomplicated and environmentally friendly method by using deionized water to form a suspension of nanoparticles from titanium targets plate.TiO_2 with particles size range from 0 to 100 nm was successfully synthesized and the characteristics of TiO_2 nanoparticlesexamined by AFM,FTIR and UV-VIS spectrophotometer respectively.*
KEYWORDS: *TiO_2 Nanoparticals, Pulsed laser ablation (PLAL), Nd:YAG* laser, green synthesis method
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I. INTRODUCTION

Nanotechnology has probable application in numerous sector include paints and coating, textiles and fashion, cosmetics, foodstuff science, catalysis, etc. In addition, nanotechnology introduces a new opportunity to proceed how it evaluates, observe, administer. Nanotechnology has emerge as a rising and speedily altering field. New generation of nanomaterial will develop, and with them new and probably unexpected issues. Nanotechnology is the hope of advanced growth. It is the whole thing today from clothes to foods there are every partition in its series we should encourage it more for our prospect and for more developments in our progress life[1]. One of the resources used in the last years is titanium dioxide (TiO_2) because it is harmless, is easy to manufacture and not expensive [2].and used as sunscreens for filtration of UV-light [3] .TiO_2 is in nature accessible material. It is an inorganic semi-conducting oxide metal. Is a highly susceptible and exceptional photo-catalyst matter[4]. Titania (Titanium dioxide) having the formulaTiO_2 ,as well as it is a metal oxide semiconductor, similar to most metal oxides, it is having a chemical resistance , thermally steady and firm [5]. Fine TiO_2 particles have been well thought-out as secure and to pose little danger to humans, telling that disclosure to this material is quite undamaging[6]. Pulsed Laser Ablation in Liquids (PLAL) has developed into a key technique for production of nanoparticles with restricted geometry and dimension. The ablation of metal targets in liquid environments is well thought-out as a certain alternative to conventional chemical reduction method for obtain noble metal colloids, as such approach is well thought-out environmental friendly (“green” method) with goods which regularly do not require stabilizing molecules or other chemical[7]. TiO_2 as nanomaterial consider as a transparent material ,and it has the ability to providing absorption for UV light, which makes it capable for producing light stabilization used for sunscreens and material coating [8]. TiO_2 consider as a semiconductor because it has a unique properties for using it in solar cells. the small size of titanium dioxide nanoparticles result in high surface area ,which makes it advantageous for devices and equipment containing TiO_2 NPs , as well as it is facilitating the (reaction\interaction) of both interacting media and equipments ,these occurs generally at the surface depending on the surface area[9].

II. MATERIALS AND METHODS

Titanium target (purity 99.7%) immersed in the bottom of Pyrex tube containing 2 ml of DIW,used as a target for synthesis of TiO_2 nanoparticles, a plate of titanium was cut to provide (2×1.4) cm dimensions. For applying the pulsed laser ablation method the experimental set up as shown in (Fig.1) consists of A Q-switched Nd:YAG laser (1064 nm,1 Hz) the target immersed in deionized water DIW , the level of the DIW above the target was 10 mm ,only DIW water used no other chemicals were used for synthesis of TiO_2 nanoparticles.

The laser beam set up perpendicular to the titanium plate target, by changing the distance between the focusing lenses and the target the spot size (diameter) of laser beam was obtained, it was 1 mm. Laser pulsed energy was varied (100,400,800)mj, with repetition rate at 1Hz and pulse duration 10ns. The number of laser

shot was 1000 pulse. The experiment was carried out at room temperature .Size, optical properties and distribution of colloidal TiO_2naonparticles were obtained by using AFM,SEM, UV-VIS spectroscopy by,FT-IR.

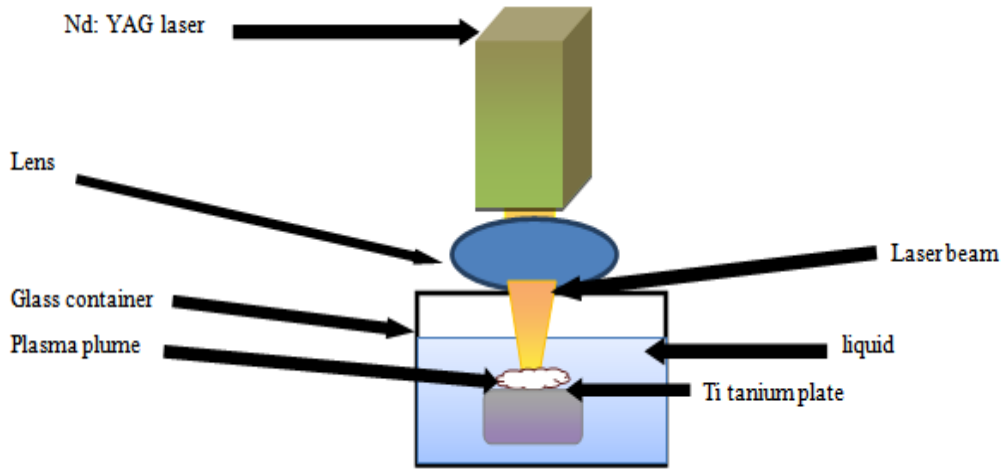

Figure1. Experimental setup for laser ablation

III. RESULT AND DISCUSSION

Different methods have been used to get a desired result for synthesis of TiO_2 . It is not toxic, easy to produce, cheap and environmental friendly ("green" technique). PLAL is a useful technique used for fabrication of the material [9],consider as multipurpose means throughout the proper choose of confining liquids solid targets [10].

TiO_2 nanoparticles syntheses were indicated successfully by UV-VIS spectroscopy by apparent of broadening beak of the absorption spectra at 211 nm as shown in (Fig.2).

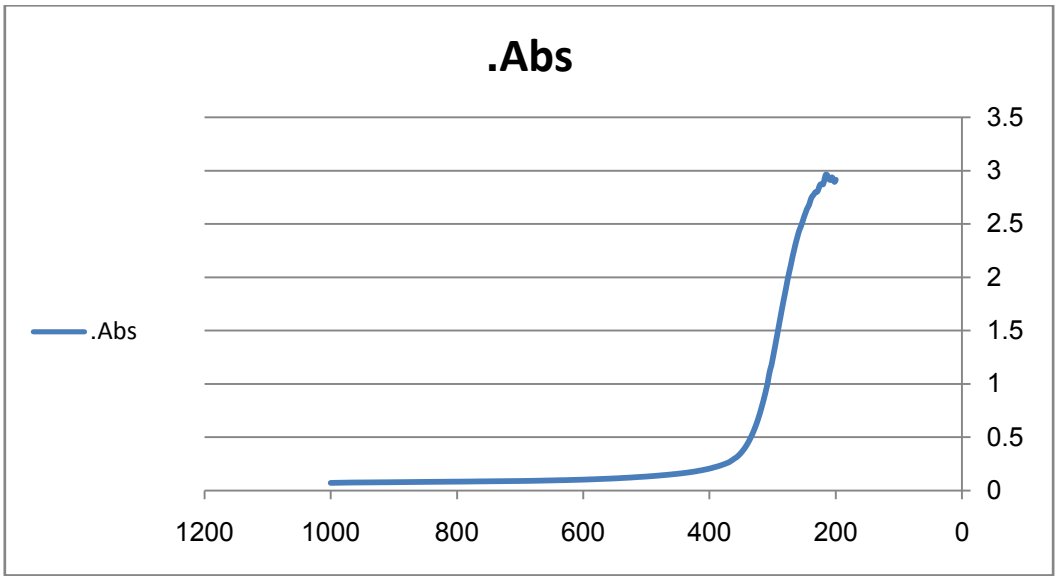

Figure2. Absorption curve of TiO_2nanoparticles synthesized by PLAL.

To identify the structural properties of TiO_2 nanoparticles, AFM was used to identify the particles size, Characterization of nanoparticles that having a diameter 0.5 nm and larger, Nanoparticle combination distributions,and the geometry of nanoparticles.

The Granularity Cumulation Distribution Report show that the synthesized TiO_2 nanoparticles having Avg. Diameter 37.22 nm as shown in (Fig.3), and an average height about 13.429 nm manifested in (Fig.4), and a 3-D image of TiO_2 nanoparticles as shown in (Fig.5).

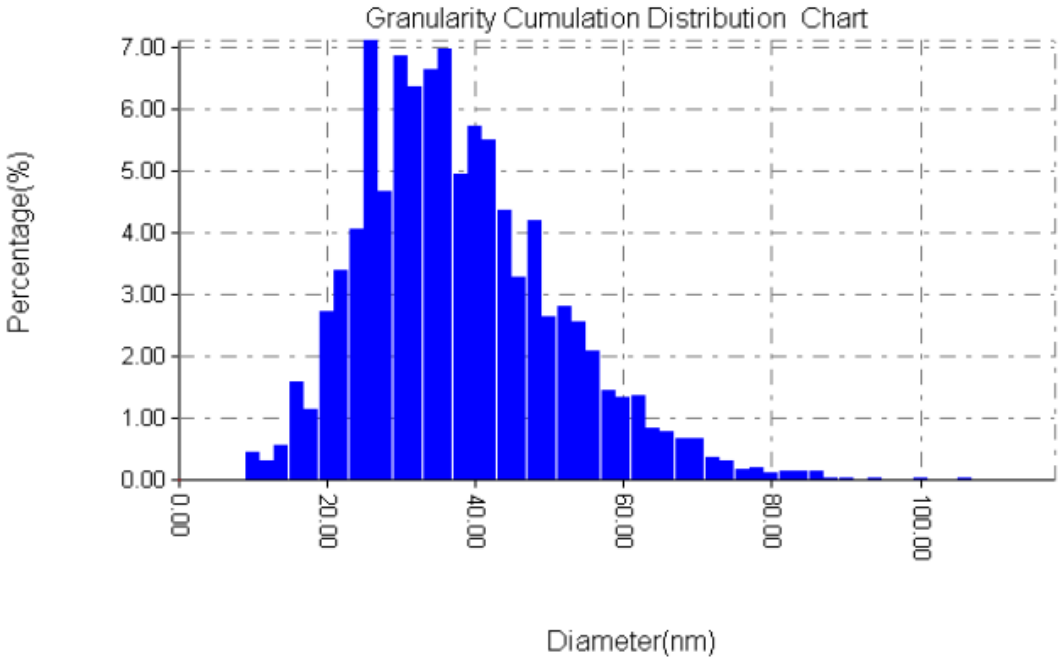

Figure3. The Granularity Cumulation Distribution chart by AFM.

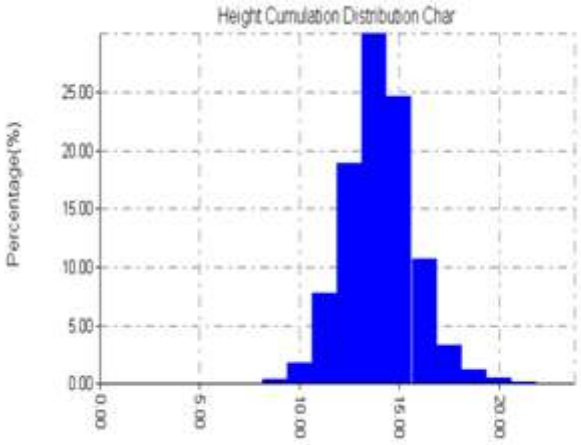

Figure4. Height Cumulation Distribution chart

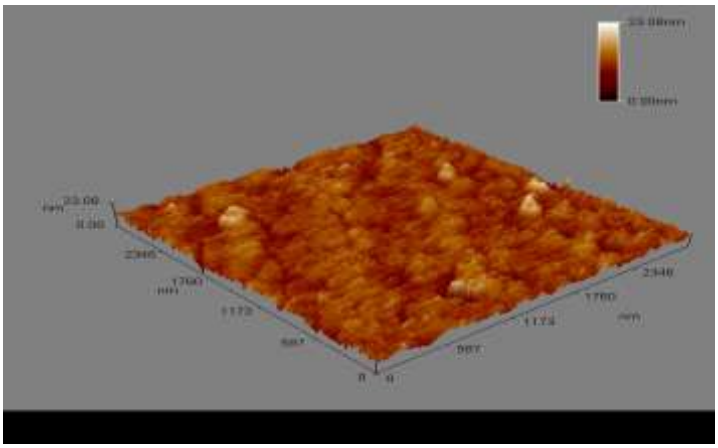

Figure5. The AFM image in 3-D for TiO2 nanoparticle

FTIR was used to calculate the functional groups present in TiO_2 nanoparticalesas shown in figure 5. The peaks at (3256.57) and (1637.29)cm^{-1} in spectra are due to the stretching and bending variation of the –OH group. The stretching variation of Ti-O-Ti is shown at peak 1309.41 cm^{-1} of the spectrum. The stretching variation of TiO_2 is shown at peak 619.01 cm-1 of the spectrum as shown in (Fig.6).

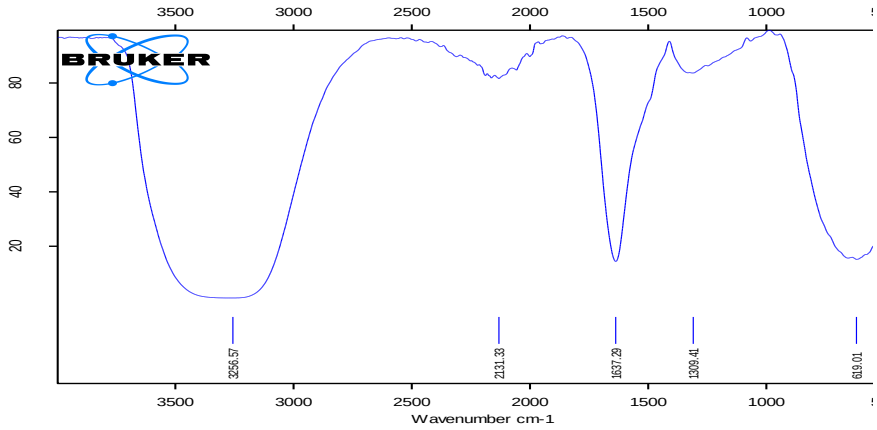

Figure 6.FT-IR spectroscopy of TiO_2 nanoparticales.

Image from Scanning Electron Microscope is produced by the interaction between the SEM electron beam and the atoms of the sample at various depths, To give sample composition and surface topography**.** The SEM is used to recognize phases based on qualitative chemical analysis and crystalline structure. The surface morphology of TiO_2 NPs was characterized by SEM, (Fig.7) presents the SEM image of TiO_2 nanoparticles , and EDX OF TiO_2 appears in (Fig.8).

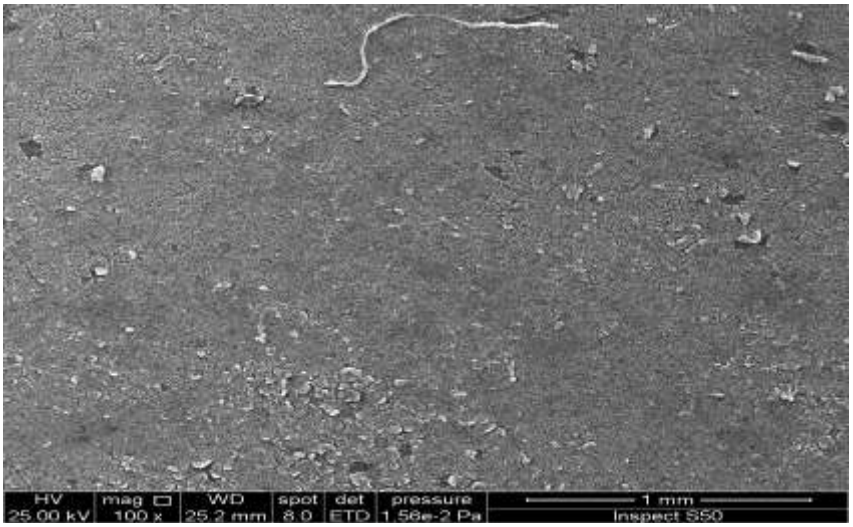

Figure7. SEM image

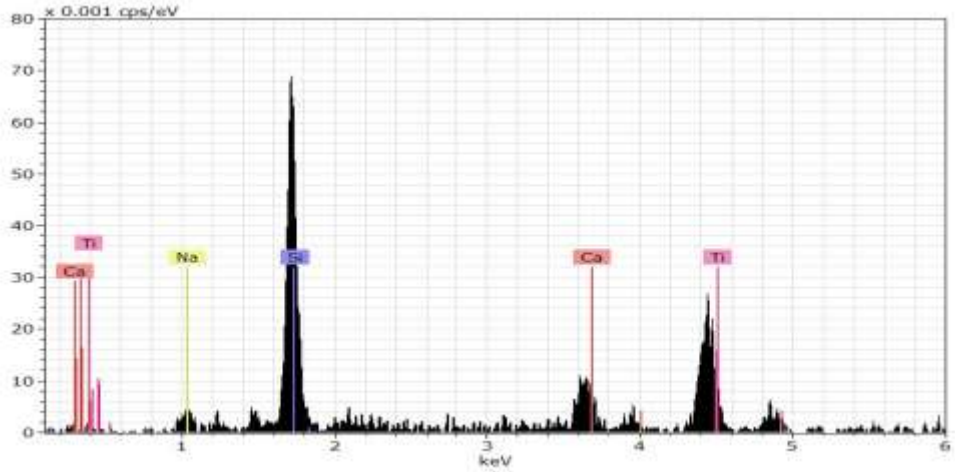

Figure8. EDX OF TiO_2

IV. CONCLUSION

This study is represented the synthesis of titanium dioxide nanoparticles by PLAL using Q-switched Nd:YAG laser (1064 nm,1 HZ) with different energies and frequencies, by using a solid metal target in DIW . The characteristics of The colloidal TiO_2naonparticles were obtained by different techniques such as AFM, SEM, FT-IR, and UV-VIS spectroscopy. The results of all the tests reveal that TiO_2 was successfully synthesized by physical method (PLAL).

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