

Synthesis and characterizations titanium dioxide nanocomposite by laser ablation for antimicrobial applications

Abstract

A composite nanoparticle containing Titanium Dioxide is synthesized by pulsed laser ablation. Oxide nanoparticles NPs have wide ranges of physical, chemical and biological properties. The main advantages In the present work, studying the characterization of colloid TiO_2 NPs were synthesis by PLAL and investigated the antibacterial activity of colloidal TiO_2 NPs compared to the antibacterial activity of synthesized composite nanoparticles was tested against four different pathogen bacteria two-gram negative (*Escherichia coli* (*E. coli*), *Klebsiella pneumoniae* (*K. pneumoniae*)), institute of bioscience UPM university kindly supplied these bacteria. The bacterial suspension was made and adjusted by comparison against 0.5McFarland turbidity typical ($5 \times 10^7 \text{ cell ml}^{-1}$) tubes. It was further diluted to obtain a final of $5 \times 10^6 \text{ cell ml}^{-1}$. All bacteria strains were culture in agar media. The media was inoculated by the 0.2ml/5ml with either the bacteria strains, then added 0.5ml of TiO_2 nanoparticles at concentration 200, 400, 600 ml^{-1} . The samples were incubated at 37°C . The bacterial growth was measured by optical density that absorbs strongly at 532nm wavelength. Conclusion that is the mean values of inhibition were calculated from triple evaluation in each assessment.

Keywords: antibacterial, nanoparticles, titanium dioxide

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Introduction

In this work, composite nanoparticles containing carbon nanotubes and TiO_2 NPs nanoparticles are incorporated by pulsed laser removal of graphite and TiO_2 NPs focuses on that were inundated in de-ionized water. The beat laser utilized was Nd:YAG laser of 1046nm wavelength at various laser vitality densities that going (5.22-13.07) J/cm^2 and an alternate number of pulsed (100-400) pulsed.^{1,2} The optical properties of arranged impacts are explored when doping the carbon nanoparticles with TiO_2 NPs nanoparticles. The UV-vis assimilation spectra displayed a red shift as the doping proportions with iron oxide nanoparticles were expanded. While, the photoluminescence of carbon nanoparticles doped TiO_2 NPs oxide nanoparticles showed a consistent fluorescence outflow tops in noticeable locale at 597nm upon excitation at a wavelength of 250nm, yet with lower power, as the doping proportion expanded, this is a result of the impact of TiO_2 NPs

nanoparticles in extinguishing the carbon nanoparticles fluorescence. The antibacterial movement of incorporated composite nanoparticles was tried against four distinctive pathogen microscopic organisms two-gram negative (*Escherichia coli* (*E. coli*), *Klebsiella pneumoniae* (*K. pneumoniae*)).^{3,4} Also, the main strategy is fluid medium strategy in which distinctive grouping of carbon nanoparticles arranged in two laser energies 80mJ and 200 MJ then doping them with various TiO_2 NPs nanoparticles, the best outcomes were gotten from the 400 $\mu\text{g. mL}^{-1}$ of carbon nanoparticles doped with various proportions of TiO_2 NPs nanoparticles. The composite nanoparticles that showed the best antibacterial movement in the fluid medium strategy are tried continuously technique the great dispersion strategy and uncover that the best centralization of carbon nanotubes 400 $\mu\text{g. mL}^{-1}$ that display the best antibacterial action are improved and become better when it doped with 43% TiO_2 NPs nanoparticles (Figure 2 & Figure 3).^{4,5}

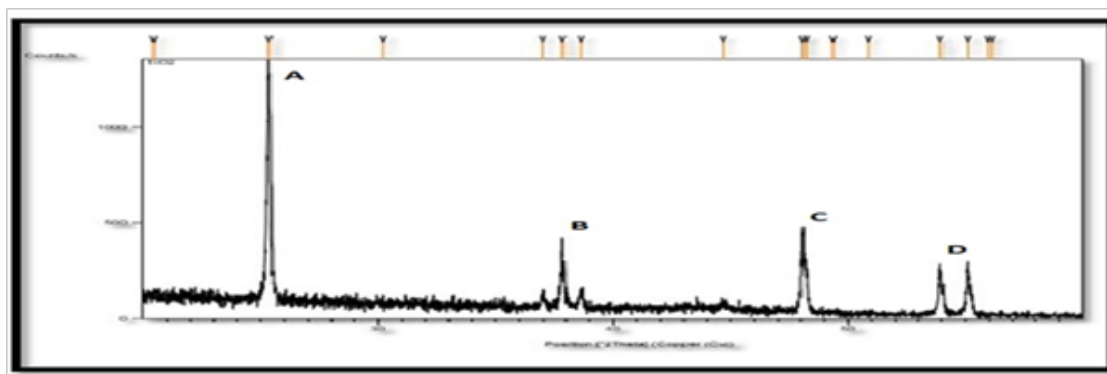


Figure 2 X-ray diffractogram and AFM of TiO_2 framework (Anatase).

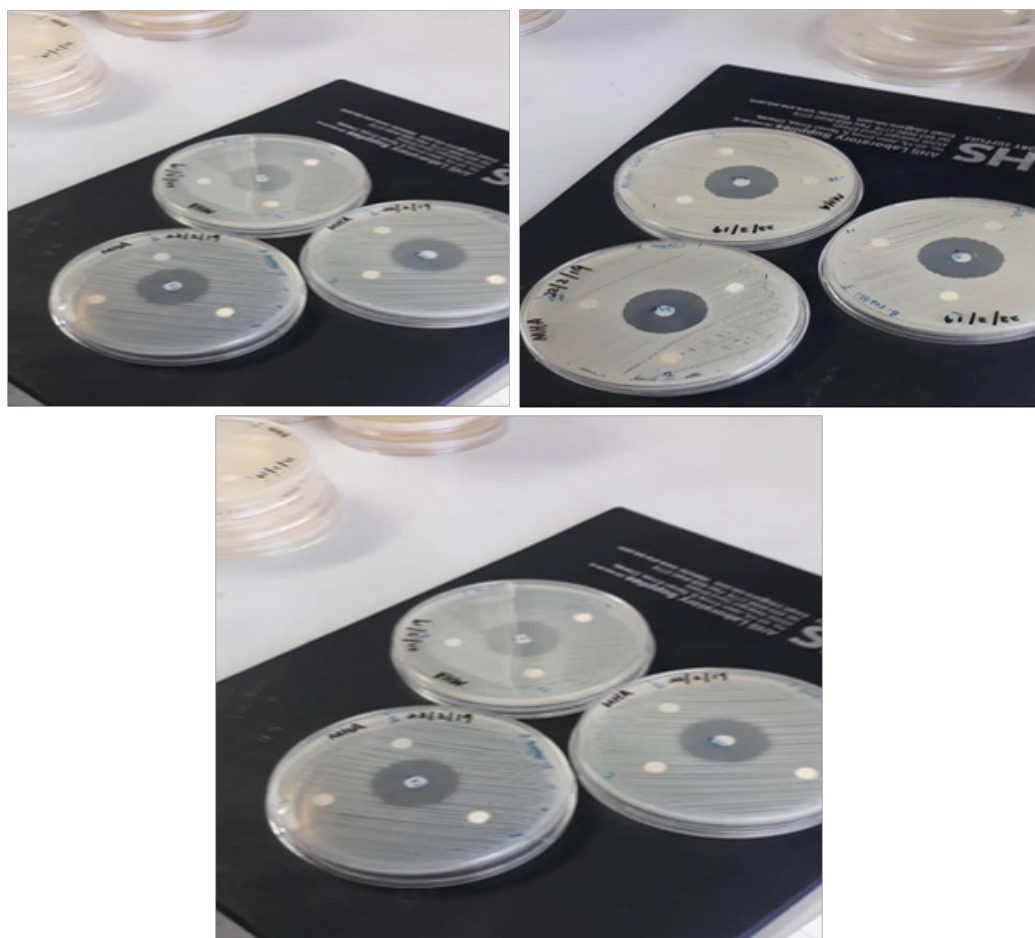


Figure 3 Experimental configuration in Laser ablation in liquid setups where a focused beam irradiates; solid target placed in pure solution a colloidal solution a solution of nanoparticles.

Research objectives

Purpose of this study that the synthesis new model of nanocomposite by modify titanium dioxide for using and clearly observed as well as low-cost and eco-friendly revealed the presence of the “knock-down” growth of pathogen bacteria and how the combination of nanoparticles increase the anti-pathogen activity. The aims of this work represented by:

- I. Preparing colloidal titanium dioxide nano composite by pulsed laser ablation technique in deionized water and synthesizing in this work,
- II. To performed laser ablation of Titanium target in water to synthesize colloidal Titanium oxide nanoparticles.
- III. To the detection surface morphology of the deposits, materials that have been studied by using atomic force microscopes (AFM). XRD pattern analysis to show that the average grain size and dimensions of TiO_2
- IV. Investigating the antibacterial activity of TiO_2 nanotubes against four different pathogen bacteria Investigating of the best antibacterial activity concentration of both modify Nanocomposite in combination with titanium dioxide nanoparticles.

Materials and methods

Experiment procedure

Synthesis of TiO_2 nano powder: Nano - TiO_2 powder was synthesized via a Sol-Gel method using titanium tetraisopropoxide (TTIP), isopropanol and deionized water as starting materials. Routines of TiO_2 nanoparticles by Nd: YAG laser (1064nm, pulse duration=9ns, repetition frequency 1Hz) operating at different Energies (80 and 200mJ) for different ablation times (10, 20min). Each sample was Heavy before and after ablation by a digital weigher to determine LAL titanium in distilled deionized plate

Results

XRD diagrams (Figure 1D) show that the four synthesized samples have the highest diffraction peak in the crystalline plane (A) ($2\theta=29.9202$) and that the other diffraction peaks coincide with the crystalline phases of (B) (25.9348), (C) (25,3439) and the smallest vertex of E(33,9715). These results have shown that we can clearly see that the crystalline phase of each sample is manly in anatase form. This result correspondence with^{1,2} AFM spectra indicated (Figure 1A & 1B) the minute size distribution between (60-135nm) for TiO_2 (anatase) and the minute size distribution between (50-150 nm), for TiO_2 doped with Sb prepared at 873k. The results show that the

TiO₂ doped with Sb has the largest surface area, followed by TiO₂ (anatase) which has a smaller surface area compared to the decrease in particle size D Avg=91.24nm and the dimer Figure 1C high Z=0.30nm between the particles is 0.30nm(1) found out goes with.⁵⁻⁷ The results also showed that a very significant difference between the groups studied (P<0.000) showed that a high concentration in women was

much higher than in the male, which confirms that the existence of the effect is generally an increase in the concentration carried out by exposure to nanoparticles. The result also showed that differences were found between the treatment group and the control group so that this finding agree with.⁷⁻⁹

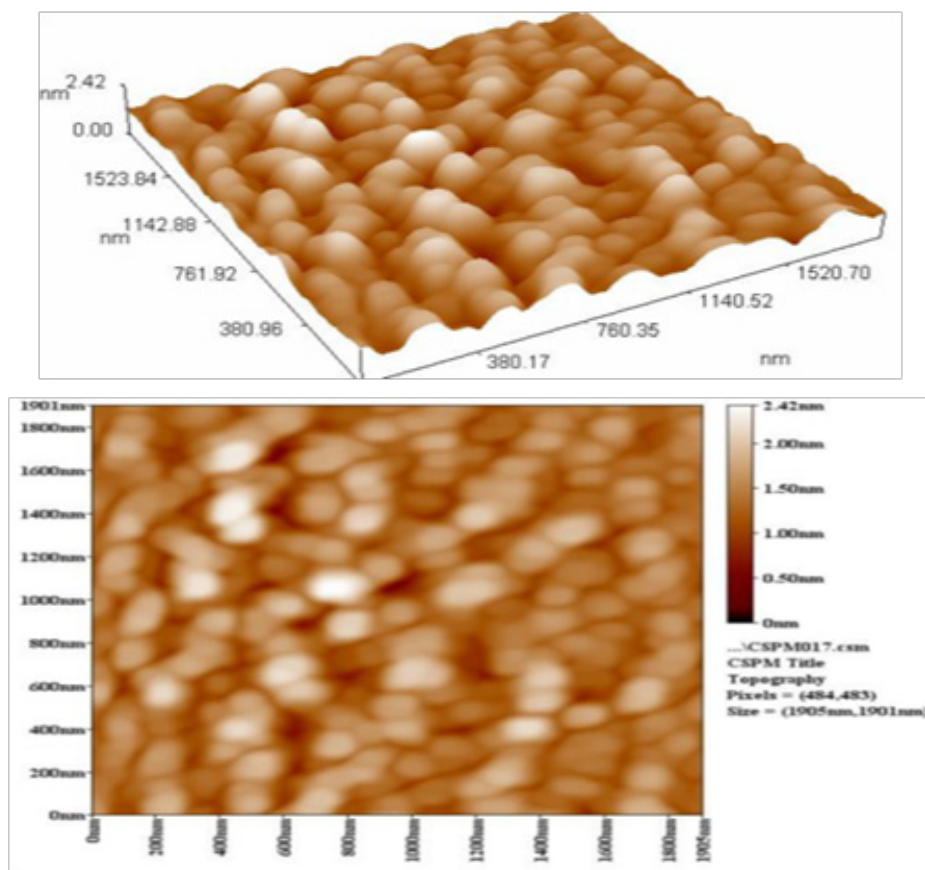


Figure 1 AFM of TiO₂ framework (Anatase).

Findings

Preparation method used led to getting titanium dioxide nanoparticles dimensions. modifying the band gap led to getting a smaller band gap (2.0eV) TiO₂-Sb. XRD, AFM crystal size, surface morphology and particle size and surface topography properties to all sample were proved the successful sights of the prepared compounds. The antibacterial activity of synthesized composite nanoparticles was tested against four different pathogen bacteria two gram negative (*Escherichia coli* (*E.coli*), *Klebsiella pneumoniae* (*K. pneumoniae*)), and two gram positive (*Streptococcus pyogenes* (*S. pyogenes*) and *Staphylococcus aureus* (*S. aureus*)) by two methods, the first method is liquid medium process in which different concentration of nanoparticles prepared in two laser energies 80mJ and 200mJ then doping them with different iron oxide nanoparticles, the best results was obtained from the 400µg.mL⁻¹ of TiO₂ nanoparticles doped with different ratios of nanoparticles. The composite nanoparticles that exhibited the best antibacterial activity in liquid medium method are tested by the second method the well diffusion method, and reveals that the best concentration of carbon nanotubes 400µg.mL⁻¹ that exhibit the best antibacterial activity are enhanced and become better when it doped with 43% nanoparticles.

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None.

Conflict of interest

The authors declare no conflict of interest.

References

1. Thongpoola V, Asanithia P, Limsuwana P. Synthesis of Carbon Particles using Laser Ablation in Ethanol. *Procedia Engineering*. 2012;32:1054–1060.
2. Delfino R, Marco C, Miguel A, et al. Influence of the per pulse laser fluence on the optical properties of carbon nanoparticles synthesized by laser ablation of solids in liquids. *Optics & Laser Technology*. 2015;74:48–52.
3. Adawiya H, Mohammed R, Duha S. Antibacterial activity of treated – multiwalled carbon nanotubes and their characterization. *J the 4th conference of nanotechnology and advanced material*. 2013.

4. Cabeen MT, Wanger C. Bacterial Cell Shape. *Nat Rev Microbial.* 2005;13:601–610.
5. Wang T, Zhu YC, Sun ZX, et al. Preparation of weak light-driven TiO₂ multi-composite photocatalysts via adsorption phase synthesis. 2015;36(2):559–567.
6. Wanazelee Wan Abu Bakar, Rusmidah Ali. Optimization of photocatalytic degradation of polybrominated diphenyl ether on trimetallic oxide Cu / Ni /TiO₂ /PVC catalyst using response surface methodology method. *Journal of the Taiwan Institute of Chemical Engineers.* 2016;62:283–296
7. López-Muñoz D, Ochoa-Zapater MA, Torreblanca A. et al. Evaluation of the effects of titanium dioxide and aluminium oxide nanoparticles through tarsal contact exposure in the model insect *Oncopeltus fasciatus*. *Sci Total Environ.* 2019;20;666:759–765.
8. Enza F, Marco S, Germana L, et al. Iron oxide nanoparticles prepared by laser ablation: Synthesis, structural properties and antimicrobial activity. *Colloids and Surfaces A: Physicochem. Eng. Aspects.* 2016;490:98–103.
9. Shu F Situ, Anna Cristina S Samia. Highly Efficient Antibacterial Iron Oxide@Carbon Nanochains from Wüstite Precursor Nanoparticles. *Appl Mater Interfaces.* 2014;6:20154–20163.