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Synthesis of TiO_2 / Ag Nanoparticles for Surface Plasmon Resonance and some biological Application

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قسم الفيزياء

تحضير جسيمات TiO_2 / Ag النانوية لرنين البلازمون السطحي وبعض التطبيقات البيولوجية

رسالة مقدمة الى

مجلس كلية العلوم - جامعة ديالى وهي جزء من متطلبات نيل درجة الماجستير في علوم الفيزياء

من قبل

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بكالوريوس علوم فيزياء 1998م

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1-1 Introduction

This chapter includes general introduction about the history of nanophysics, nanoparticles and their distinctive characteristics that made them enter in many different physical and biological applications .

1-2 History of Nanomaterial

New and improved products are produced for numerous applications . physicist Richard Feynman introduced the concept of nanotechnology in 1959 in his talk "There's Plenty of Room at the Bottom." nanoscience‟, is a combination of nano, meaning "dwarf" and the word science. nanometer refers to 10^{-9} or one billionth of a meter. For comparison, a human hair is 100,000 nm thick. nanoscience deals with the science of materials and technologies in the scale range of (1-100) nm. That means the nanoscience deals with a few hundred to a few thousand atoms or atomic clusters, whereas microscopic world is made out of trillions of atoms or molecules. nanoparticles are larger than individual atom and molecules, but are smaller than bulk solid; hence they obey neither absolute quantum chemistry nor laws of classical physics and have properties that are different from those expected.. Properties not seen on a macroscopic scale are now becoming important on nanoscale such as quantum mechanics, optics, magnetism, surface reactivity, and thermodynamics. The nanoscale is that materials that can have different properties at the nanoscale some are better at conducting electricity or heat, some are stronger, some have different magnetic properties, some reflect light better or change colors as their size is changed .

1-D nanostructures are confined in two spatial directions e.g., nanowires, nanotubes etc. 0-D nanostructures are confined in all three spatial directions e.g., nanoparticles, quntum dots etc. [1].

The nanophysics is halfway between the size scales of quantum mechanics and macroscopic physics governed by the laws of Newton and Einstein. The correct definition of nanophysics is the physics of structures and artefacts with dimensions in the nanometer range or of phenomena occurring in nanoseconds.

Modern physical methods whose fundamentals are developed in physics laboratories have become critically important in nanoscience. Nanophysics brings together multiple disciplines, using theoretical and experimental methods to determine the physical properties of materials in the nanoscale size range. Interesting properties include the structural, electronic, optical, and thermal behavior of nanomaterials ; electrical and thermal conductivity; the forces between nanoscale objects; and the transition between classical and quantum behavior. nanophysics has now become an independent branch of physics, simultaneously expanding into many new areas and playing a vital role in fields that were once the domain of engineering, chemical, or life sciences [4]. nanoscience and nanotechnology are all about relating and exploiting phenomena for materials having one, two or three dimensions reduced to the nanoscale. Breakthroughs in nanotechnology require a firm grounding in the principles of nanophysics. It is intended to fulfill a crucial purpose. nanophysics aims to connect scientists with disparate interests to begin interdisciplinary projects and incorporate the theory and methodology of other fields into their work. Their evolution may be related to three exciting happenings that took place in a short span from the early to mid-1980s with the award of nobel prizes to each of them. These were: (i) the discovery of quantum Hall effect in a two dimensional electron gas; (ii) the invention of scanning tunneling microscopy (STM); and (iii) the discovery of fullerene as the new form of carbon. The latter two, within a few years, further led to the remarkable invention of the atomic force microscope (AFM) and, in the early 1990s the extraordinary discovery of carbon nanotubes which soon provided the launch pad for the present-day nanotechnology [5].

The STM and AFM have emerged as the most powerful tools to examine, control and manipulate matter at the atomic, molecular and macromolecular scales and these functionalities constitute the mainstay of nanotechnology. Interestingly, this exciting possibility of nano level tailoring of materials was envisioned way back in 1959 by Richard Feynman in his lecture , “There’s plenty of room at the bottom" [3]. Over the past 15 years, nanotechnology has increasingly gained in importance in industry, biomedicine, and research. According to the current definition of the European Union (EU), nanomaterials are natural, incidental, or manufactured materials that contain particles in an unbound state, either as aggregates or as agglomerates. At least 50% of these particles must exhibit one or more external dimension within the size range of 1–100 nm [4] . Surface properties become more important as a function of the size reduction of a material. Thus, nanoparticles (NPs) have completely different mechanical, optical, electrical, magnetic , and catalytic properties compared with larger particles of the same composition . Hence, the bioactivity of NPs significantly differs from that of their fine-size analogues [5].

1-3 Nanoparticles

Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nanoscale this is often not the same. Size-dependent properties are observed such as quantum confinement in semiconductor particles and surface Plasmon resonance(SPR) in some metal particles. The properties of materials changed as their size approaches the nanoscale and as the percentage of atoms at the surface of a material becomes significant. For bulk materials larger than one micrometer the percentage of atoms at the surface is minuscule relative to the total number of atoms of the material.

The interesting and sometimes unexpected properties of nanoparticles are partially due to the aspects of the surface of the material dominating the properties in comparison with the bulk properties. nanoparticles exhibit a number of special properties relative to bulk material. nanoparticles have a very high surface area to volume ratio [2] . This provides a tremendous driving force for diffusion, especially at elevated temperatures. The large surface area to volume ratio also reduces the incipient melting temperature of nanoparticles [3]. Moreover nanoparticles have been found to impart some extra properties to various day-to-day products . The term "nanoparticles" is used to describe a particle with size in the range of (1-100)nm . In this size range, the physical, chemical and biological properties of the nanoparticles changes in fundamental ways from the properties of both individual atoms/molecules and of the corresponding bulk materials. nanoparticles can be made of materials of diverse chemical nature, the most common being metals, metal oxides, silicates, non-oxide ceramics, polymers, organics, carbon and biomolecules. nanoparticles exist in several different morphologies such as spheres, cylinders, platelets, tubes etc. Generally the nanoparticles are designed with surface modifications tailored to meet the needs of specific applications they are going to be used for [3] .

1-4 Classification of nanomaterial's

Nanoscale materials are defined as a set of substances where at least one dimension is less than approximately 100 nm. nanomaterial's are of interest because at this scale unique optical, magnetic, electrical, and other properties emerge. These emergent properties have the potential for great impacts in electronics, medicine, and other fields. According to the order of dimensionality, nanomaterial's can be classified as zero, one, two and three dimensional nanostructures [6].

1. Zero-dimensional (0-D) nanostructures

Zero-dimensional nanomaterials are materials where all the dimensions are measured within the nanoscale. Also named as NPs with all possible morphologies, such as spheres, cubes and platelets these NPs include single crystal, polycrystalline and amorphous particles. If the NPs are single crystalline, they are often referred to as nanocrystals. When the NPs have dimension sufficiently small and quantum confinement effects are observed, the common term used to describe such NPs is quantum dots [8].

2. One-dimensional (1-D) nanostructures

The one-dimension nanomaterials have one dimension that is outside the nanoscale. This type has been called by a change of names such as: whiskers, fibers or fibrils, nanowires and nanorods . In many cases one-dimensional systems take into account carbon-based, metal based or even oxide-based systems. nanotubes and nanocables are also considered one dimensional structures if the extension over one dimension is predominant over the other types [6-7].

3. Two-dimensional (2-D) nanostructures

Two-dimensional nanomaterials are materials in which two of the dimensions are not confined to the nanoscale. They are one more important nanostructure, they include many shapes such as nanofilms, nanolayers, nanocoatings and nanodiscs, and thus they have been a subject of intensive study for almost a century [4-7].

4. Three dimensions (3-D) system

Three-dimensional nanomaterial's , as well known as bulk nanomaterials, are relatively difficult to classify. However, it is true to say that bulk nanomaterial's are materials that are not confined to the nanoscale in any dimension. These materials are thus characterized by having 3 randomly dimension above 100 nm [6].

1-5 Noble Metal Nanoparticles

The noble metal nanoparticles such as Ag NPs have been the source of much interest due to their new electrical, optical, physical, chemical and magnetic properties [9]. It was very attractive for biophysical, biochemical, and biotechnology applications due to its unusual physical properties, especially due to its sharp absorption peak in the visible region. Silver nanoparticles are chemically stable. The resonance frequencies are strongly dependent on the shape and size of the particle as well as on the optical properties of the material within the near field of the particle [10]. Silver, for example, has been used for thousands of years as an antiseptic. On the other hand, one cannot ignore its catalyst value [11].

1-6 Titanium Dioxide Nanoparticles

It gained importance (TiO_2) according to its high stability, low charge, biocapacity, reusability, and effect of uses mainly in photo catalysis, catalyst enhancement, antibacterial, conservative re-mediation, air disinfection, and water purification [29]. TiO_2 has a compressive force that oxidizes in the direction of eliminating microorganisms under brilliant UV light [30,31]. Recent research has revealed interest in the mineral as nanoparticles in many disciplines as a photocatalyst as it is in water sterilization [25]. In addition, TiO_2 can also be practical in coatings, air purification, plastics, paper inks, pharmaceuticals, pharmaceuticals, food products, cosmetics, radiation protection, photo catalysis, sensor and toothpaste [26-27]. It is even used as a dye to color skim milk [28].

Currently, nanoparticles of Titanium dioxide properties are one amongst the most important fascinating analysis subjects because of extremely result accomplishment in biological, pharmacological submissions, environment substance decontamination, electronics arrangement, solar power cells, photo-catalysts, photo-electrodes in addition gases sensor of aboard American Food and Drug Administration (FDA) commendation of persecution in technology of nutrient besides medicines, ointments, paint pigments, cosmetics, also dentifrice [32].

1-7 Properties of Titanium Dioxide Nanoparticles

The last few years the preparation of metal oxide nanostructures in desired compositions has received great interest due to their unique properties and potential for use in many applications. Titanium dioxide (TiO_2) is one of the oxides of metals, and it is a chemical compound that contains a solid inorganic substance with a white color, thermally and chemically stable, cheap and nonflammable and is not classified as a hazard. Titanium is the ninth most common element in the earth's crust [33]. nanotitanium is the most promising nanomaterial as semiconductors and that the diffusion of titanium nanoparticles in very fine sizes are suitable for most applications such as Adsorbents, Pigments and Catalytic supports. The presence of titanium dioxide in different sizes and shapes such as spherical Spheres. nanorods, fibers, tubes, and sheets have attracted interest for their use in many fields [34]. Crystalline titanium dioxide is found in three different phases (Rutile), (Anatase) and (Brookite). These phases are characterized by high refractive index, low absorption and spread in the visible region and near-infrared spectral regions, and high chemical and thermal stability [35].

The thermodynamics of the (Rutile) phase is more stable while (Anatase and Brookite) is unstable and can be converted into the (Rutile) phase when heated above (600-800) ^{o}C [36] Titanium Dioxide (TiO_2) has the ability to Elimination of organic pollutants in various media. In addition, (TiO_2) can be used in coatings (coating) [37] , plastic, cosmetics and photo catalysis. It is also used in many applications and in various fields such as aerospace, sport, medicine, and in food products to increase the shelf life of products. [38] . Semiconductors such as (TiO_2) have great importance in eliminating various organic environmental pollution by irradiating the semiconductor (TiO_2) with a light energy greater than its gap, which can generate the (electron-gap) pair [39] . Therefore, the development of a one-step method such as the Pulse laser ablation in liquid (PLAL) method for preparing (Rutile TiO_2) nanocrystals at room temperature is important as it has some advantages over the (Anatase) phase such as its good effect on light scattering, optical reflections, non-toxicity and chemical inertia [33].

The phase rutile has a higher refractive index, higher dielectric constant, higher electrical resistance, and higher chemical stability [40]. Because of the small size of these nanoparticles, they have the ability to interact with light, which results in the retention of light inside the nanoparticles that generate new nonlinear phenomena such as the collective oscillations of electrons inside the conduction beam in the spherical nanoparticles moving by the external electric and magnetic field, which is called the Plasmon resonance Localized Surface Plasmon Resonance (LSPR) which can be adjusted by changing the properties of the nanoparticles such as shape, size and liquid medium. This is widely used in medical applications of biosensor systems, photocells, and active catalysis processes [41].

1.8 Silver Nanoparticles

Silver nanoparticles are of increasing interest for scientists due to their very good biological properties and limited side effects. Used since 1000 BC, silver proved its biocidal activity for a wide number of bacteria and recently it was also known to be active in the treatment of cancer [12,13]. As a consequence of silver multifunctionality (antiseptic [14], antitumoral [15, 16] . and IR-sensitizing agent [17] . Silver nanoparticles are widely used for their biological activity as colloidal suspension [18–19] , or in association with other materials [20,21] . Silver nanoparticles were associated with different components such as manganite [22]. carbon nanotubes [23]. hydroxyapatite [24, 25]. and chitosan [26]. Mostly, silver nanoparticles play antibacterial [24].

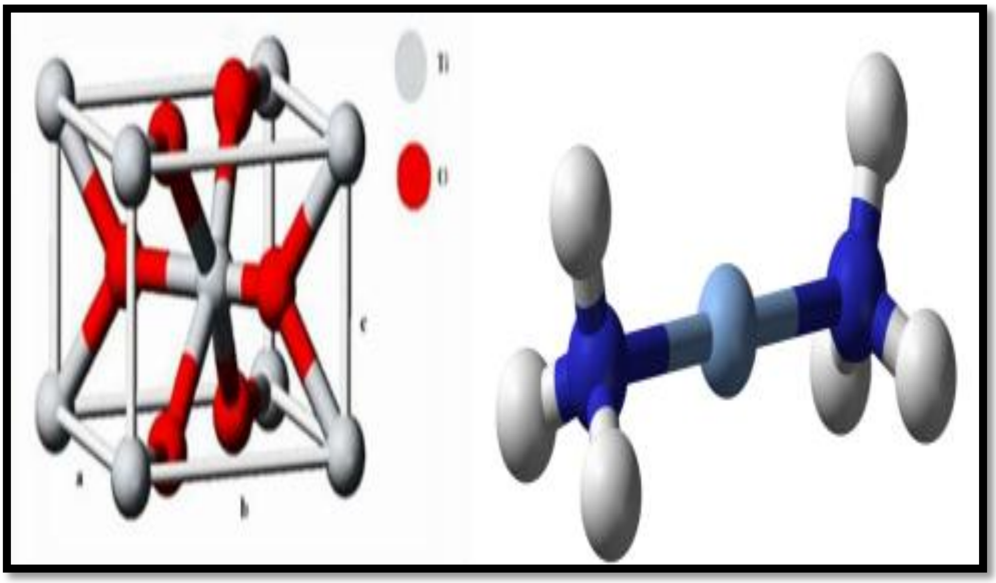

Figure (1-1) The rutile crystal phase of titanium dioxide and Crystal structure of silver [33].

1-9 Advantages of Pulsed Laser Ablation In Liquid

Nanoparticles can be prepared using various techniques including chemical reduction, electrochemical reduction, laser ablation [42], pulsed laser deposition, photo reduction, and flame firing. Metal Combustion, Electrolysis, Spark Discharge, and Chemical Liquid Deposition (Chemical Fluid Deposition) [43]. Among the different methods, the method of pulsed laser ablation in liquids (PLAL) is an important technique for manufacturing nanomaterial’s with a (top-down) technology, which is a versatile technique for numbers of different types of nanoparticles such as metals, alloys, oxides and similar Semiconductors [44] and Noble Metal [45].

Among the advantages of the (PLAL) method: -

1- Inexpensive equipment to control eradication conditions [46].
2- Simple and clean preparation compared to the chemical process that pollutes the final product and the environment [47].
3- The nanoparticles can easily be obtained well in one step without subsequent heat treatment due to the high active state of the alienated species [48].
4- Producing materials at extremely low temperatures and low pressure. [49].
5- Manufacture of two or more materials simultaneously [49].

Through practical experiments, it has been proven that the size of the resulting material can be controlled by changing the various parameters such as the wavelength of the laser, the duration of the pulse and the pH of the solution [49]. In (1992) this technique was developed for the purpose of preparing large quantities of nanoparticles when submerging materials in water and irradiating them with a pulsed laser [50]. The synthesis procedure of the metallic nanoparticles affects the final colloidal state in terms of aggregation, reaction and formation of the primary shell [51].

1-10 Surface Plasmon Resonance (SPR)

Irving Langmuir first proposed the name of plasma in (1929) to describe the collective electrical properties that he observed in ionized gas and from that time on the so-called gaseous plasma physics. The plasma is a medium that includes equal concentrations of positive and negative charges, and one of these charges is at least moving in the steel. The negative charges of the conducting electrons are equivalent to an equal concentration of the positive charges of the ions. That the plasma oscillation in a metal is a collective excitation or excitation of an electron gas, as all the electrons oscillate in a coherent and coherent manner, and this arises due to the characteristic of the long order of the Coulomb forces [47].

A Plasmon, similar to a photon, and a phonon is generated from free electrons that vibrate collectively in the metal as the collective oscillation of electrons conduction by light. The term resonance refers to the oscillation of the plasma excited by electromagnetic waves. The term surface is used because the surface polarization is the origin of the plasma oscillation when light of a specific wavelength falls on the surface of a metal, and an interaction occurs between the surface of the Plasmon and the photon, and this is called surface Plasmon Bernin (SPR) [52,53].

The alternating surface charges form an oscillating dipole that radiates electromagnetic waves. The resonances are at a visible frequency for noble metals such as gold and silver, as they give the colors important optical properties and characteristics. Some photons will be released with the same frequency in all directions, and this process is known as scattering. At the same time, some photons are transformed into phonons or vibrations of the lattice, and this process indicates absorption. In general, the surface Plasmon resonance peak of the metallic nanostructure must include both the absorption and dispersion components. Figure (1-1-a) shows a simple model that shows the Plasmon's of a particle as all conducting electrons move in phase producing only dipole-type oscillations and are shown by a single, narrow, one vertex in it.

Surface Plasmon resonance spectrum. This leads to an increase in the size and field across the particle to become irregular and this phase leads to exposure of the dipole resonator and its high irritation as shown in Fig. (1-1-b) and leads to several peaks in the spectrum [54].

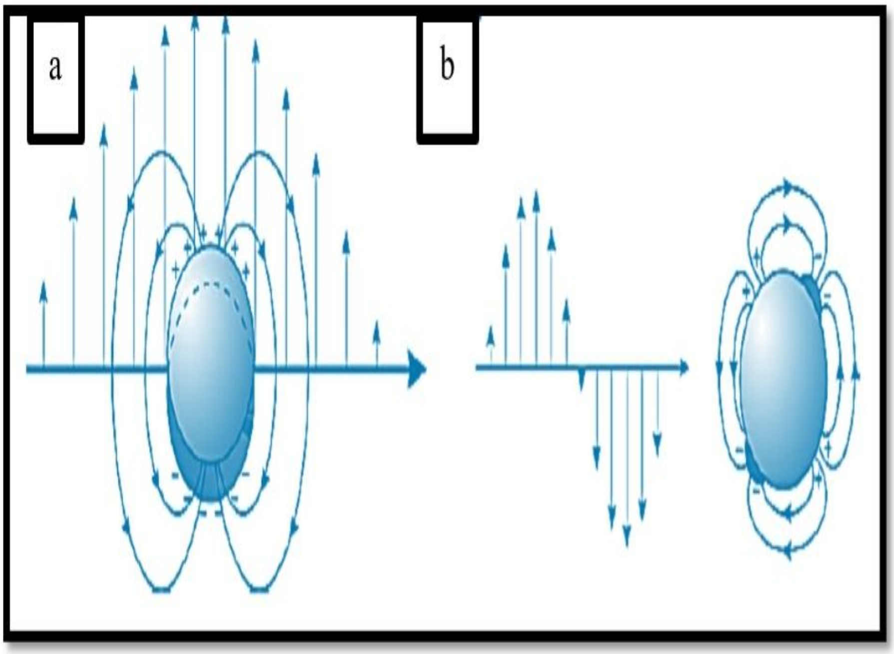

Figure (1-2): (a) The Intensity of A dipole Particle, (b) The Quadruple Radiation of Large Particles [33].

1-11 Literature Review

- Researchers (Ali and Raouf) in (2011) prepared silver nanoparticles using a pulse laser (Nd: YAG) with wavelength nm (1064) and time of ns (10) and energy 100-900 mJ) in distilled and deionized water. The nanoparticles were The resulting silver has a size of nm (5-50) with a spherical shape [42].

- Adawiya J. Haider et al. (2013) studied TiO_2 $TiCl_4$ nanoparticles prepared as precursor with a 1:10 ethanol solution in ambient atmosphere, without additives. The structure, morphology and size of the nanoparticles were examined by X-ray diffraction and electron microscopy (SEM). Optical properties were studied by means of a visible ultraviolet spectrophotometer. The results showed that the anatase phase was only in the titanium dioxide powder up to 500. The average size of TiO2 nanoparticles was obtained in the range of (3- 30) nm. TiO2 particles synthesized at concentrations of 10-5 and 10-3 showed superior antibacterial activity with two types of bacteria, Escherichia coli (E-coli) and Staphylococcus aureus respectively. TiO2 nanoparticles are more effective as antibacterial agents with Staphylococcus aurous compared with E-coli [55].

- (Khashan and et al.) in (2014) prepared colloidal titanium dioxide nanoparticles by laser ablation of titanium metal immersed in anionic water. They studied the properties of suspended nanoparticles using the ultraviolet (UV-Vis) spectrum, Fourier transform infrared (FTIR) and the transmission electron microscope (TEM). The researchers explained through the (FTIR) examination of the formation of titanium oxide particles, and the results of the (TEM) images showed that the granular size of the nanoparticles ranges between nm (3-30). The researchers used the prepared nanoparticles as an anti-bacterial against (Staphylococcus aureus) and (Escherichia Coli). Titanium dioxide nanoparticles have shown inhibition activity in bacteria [56].

- Lakshmipathy and Nanda (2015) prepared silver nanoparticle chemically from gallic acid, and studied its biomedical application. UV– Vis spectrum showed narrow peak with λmax at 424nm. FESEM micrograph show the narrow size distribution of AgNPs with size <30nm and spherical to nearly spherical in shape. AgNPs showed potent antiproliferative activity on HEp-2 cells with IC50<1mg/mL concentration accompanied by morphological disturbances and membrane damage. The strong affinity toward intracellular proteins and thiol formation accounts for its toxicity which may further be extended for varied biomedical applications as a broad spectrum therapeuticagent [57].

- Salman in (2016) used the method of pulsed laser ablation in liquids to prepare nanoparticles of titanium oxide by placing a piece of high-purity titanium 99.9% in (2) ml of deionized di-ionized water using a (Nd: YAG) laser) At nm wavelengths (1064,532) and a laser energy of mJ (500). The researcher studied the properties of the resulting solution by X-ray diffraction (XRD), atomic force microscopy (AFM) and absorbance spectroscopy (UV-Vis), and through the results of the tests conducted for titanium oxide nanoparticles, the average diameter of the resulting particles ranged between nm (84.78 95.96) at nm wavelengths (532,1064) respectively [58].

- Caroline and her group (2017) synthesized silver nanoparticles using a pulse laser ablation method with a wavelength of 1064 nm at 35 nm pulse width with different effects of silver target radiation in different environments (water, ethanol and acetone). They found that the visible UV-visible absorption spectra of the nanoparticles peak the absorption of the surface Plasmon resonance in the ultraviolet region. They used STEM and TEM micrographs to assess the size and shape of the nanoparticles. The results showed that the properties of the silver nanoparticles and their production rate were strongly influenced by the diversity of the laser effect and the liquid medium. Particles in diameter from 2 to 80 nm were produced using various conditions. This work provides evidence of promising studies to produce small nanoparticles using high power lasers[59].

- (Noori and et al.) in (2017) prepared nanoparticles for silver using a (Nd: YAG) laser by the method of ablation of pure silver metal immersed in distilled water using different energies of the mJ laser (100,600) using Pulse (200), and the researchers studied the effect of the preparation conditions On the structural and optical properties, and then studying the effect of nanoparticles on the killing rate of two types of bacteria, staphylococcus and coli [60].

- Acharya et al. (2017) studied comparative antibacterial properties of Ag and Ag@SiO2 core-shell nanoparticles. UV–Vis spectrum showed the SPR peak of AgNPs at 425nm while for silica coated silver nanoparticles, the SPR peak shifts to 426nm. TEM photography showed that average size of AgNP ~14nm and average size of silica coated silver nanoparticles ~17nm [61].

- (Aldama-Reyna and et al.) in (2018) produced silver nanoparticles by laser ablation method (Nd: YAG) for a target of pure silver metal immersed in distilled water at a depth of mm (10) and at the wavelength of the laser used nm (1064) and energy (20.4) mJ, pulse time (6) ns and repetition rate Hz (10). The researchers studied changes in the optical properties of colloidal solutions and through the use of ultraviolet (UV-Vis) spectroscopy, which showed that a characteristic peak was attributed to the spherical silver nanoparticles [62].

- Prahlad and his group (2018) studied the effect of incident laser energy on surface plasmon resonance (SPR) and the size of silver nanoparticles that were synthesized by pulsed laser ablation of silver immersed in distilled water. The expansion in the plasmon bandwidth of the synthesized nanoparticles with the increase in the laser power on the silver target indicates the decrease in the size of the nanoparticles. This is confirmed by electron microscopy (TEM) images showing a decrease in the mean nanoparticle size from about 15 to 10 nm with an increase in the incident laser power from 30 to 70 mJ, respectively. The structural features as revealed by the electron diffraction studies in the selected region and the ultra-fine TEM studies confirmed the composition of both the silver nanoparticles and the silver oxide [63].

- Rusul K. Ismail et al (2019), studied the chemically synthesized silver nanoparticles (Ag NPs) made of gallic acid, characterized by UV-visible absorption spectroscopy and TEM. Next, the effect of surface plasmon resonance (SPR) of Ag NPs against the MCF-7 cell line was examined. A common colloidal silver solution has been described. UV-visible absorption spectroscopy showed that the particles exhibit a narrow band with maximum absorption at 396 nm. Based on the TEM results, Ag NPs were spherical in shape (average diameter was 11.6-15.2 nm). Besides, the cytotoxic effect of Ag NPs against MCF-7 was enhanced with increasing concentration. The IC80 value was assessed at 50 µg / mL Ag NPs at 72 h [64].

- Muhammad and his cohorts (2019) fabricated silver nanoparticles using the pulse laser ablation method in which a high purity (99%) silver plate was dipped in 25 mL in a 50 mm petri dish. Focused on a pulsed (Nd: YAG) laser (1064nm, maximum power 50mJ, 7ns) laser with a convex lens with a focal length of mm30. The laser repeat rate was 10 Hz, and the laser bombing time of the target was 13 hours. The researchers' results show that the colloidal silver solution has a yellowish color. Moreover, the silver nanoparticles produced have a spherical shape with an average diameter size of tens of nanometers [65].

- Lucija and her cohorts (2020) produced silver nanoparticles by laser ablation (Nd: YAG) in distilled water for a target of pure silver metal and studied their biological applications through their inhibitory effect on growth on E.coil bacteria, and they determined the time it took for the silver nanoparticles to kill cells. Bacteria before being more virulent [66].

- Abubakr (2020) used ice water as a medium to produce silver nanoparticles (Ag NPs) by pulsed laser ablation. A nanosecond laser with a wavelength of 532 nm is used to produce silver nanoparticles in ice water. The results showed that the average size of the nanoparticles was 16 nanometers, ranging from a few nanometers to 40 nanometers. For comparison, nanoparticles were produced in deionized water under the same laser beam parameters where the average size of nanoparticles was 31 nm. From this it can be concluded that the ice environment has a significant effect on reducing the size of Ag NPs [67].

- Saif Khalil (2021) studied and prepared nanoparticles by using the technique of pulsed laser ablation in liquid, as the pulsed laser (Nd: YAG) with wavelength (1064 nm) was used for targets of gold and cinnamon with different number of pulses. The structural and optical properties were studied, and the results of the FE-SEM measurement of the prepared nanoparticles showed that with the increase of the number of laser pulses, the diameter of the nanoparticles increases and they are spherical in shape with the presence of some clusters and complexes. The results of (EDX) showed the primary components and chemical elements present in the samples .The results of UV-VIS showed that several peaks were obtained at different wavelengths . The prepared nanoparticles with different laser parameters in ethanol medium are used as antagonists against strains of negative and positive bacteria (EC, PA, SA) [68].

- Muhammad .M . M.S.Saeed Al-Obaidi (2021) studied the preparation of silver and copper particles using a pulsed laser ablation technique in liquid (PLAL) for a target immersed in deionized water (distilled water). After the prepared solutions of silver and copper were obtained, the silver solution was found to contain spherical nanoparticles and nanoparticles, the size and surface morphology were studied by transmission electron microscopy (TEM), the size distribution of nanoparticles and the nanoscale solutions were examined by UV visible spectrophotometer. . FE-SEM and XRD tests and X-ray energy dispersal spectrometry (EDS) showed that the powders used in this study (silver and copper) have nanostructures and (XRD) results showed that the crystal system is cubic and polycrystalline and that the predominant crystal plane orientation is (111). Biologically, the inhibitory activity of radioactive and non-radioactive solution of silver nanoparticles, silver powder, antifungals and bacteria on Candida yeast species and bacteria species, the study showed that nanosolutions or nanopowder did that. It does not affect the growth inhibition of Candida species and the bacteria under study and it also affects some types of bacteria [69].

1-12 Aim of the Work

The aim of the present work

1- Enhancing the optical properties of TiO_2/ Ag .
2- Preparation hybrid nanoparticles by synthesis low cost .
3- Use TiO_2/ Ag for antibacterial applications .