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Original Research

Study of Optical and Structural Properties of Te/chlorophyll Nano-composites

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Abstract:

In this research tellurium particles Te were prepared(TeNps) nanoparticles using a 1064nm Pulsed Nd-YAG laser , the energy of 80mJ and the frequency of 6HZ and then the preparation of the nanocomposite Te / chlorophyll by adding chlorophyll to the tellurium nanoparticles. Then, the optical properties of each were examined TeNPs and Te/chlorophyll nanocomposites Using the uv_visibel device An absorption peak was obtained at the wavelength of 292 nm for tellurium nanoparticles And the occurrence of a blue shift for the element Te (Bulk) The blue shift indicates that the smaller nanoparticle values are present In the visible range, the chlorophyll formula helps the prepared nanocomposite to obtain a broad spectrum and a greater absorption of incoming solar energy, and thus obtain high solar energy.

Keywords: Te/chlorophyll Nano-composites, Optical, Properties

Introduction:

Nanotechnology is a technology that studies, understands and monitors matter with dimensions ranging between 1 and 100 nanometers, which can be used in all different scientific fields, such as: physics, chemistry [1], biology, materials science, and engineering. It is worth noting that the term nanotechnology or nanotechnology relates to the fundamental understanding of physical, chemical and biological properties at atomic and molecular scales, and the controlled control of these properties to create functional materials and systems with unique capabilities.

The Discovery of Nanotechnology Ideas and concepts began to form for nanoscience and technology long before its use, when physicist Richard Feynman, at the meeting of the American Physical Society at the California Institute of Technology on December 29, 1959, proposed a topic entitled “There There's Plenty of Room at the Bottom, where Feynman described a process in which scientists can control and influence [2, 3] individual atoms and molecules, and after a decade of his exploration of ultraprecision machining, Professor Norio Taniguchi invented the term nanotechnology, and until 1981 nanotechnology began with the development of the scanning tunneling microscope, through which small individual atoms can be seen.

Nanotechnology allows the production of products that are considered imaginative compared to what is available today, and it also provides a wide network of uses that include multiple fields. Nanotechnology is one of the modern technologies that still needs a lot of research and studies, and it is, as many nanoresearch centers state, the technology of the next era. We can call our coming era the "Nano Era," as this technology will have a major impact in many areas of industrial, military, medical, and agricultural life, in the field of transportation and aviation, in space research, and in many important vital fields. [4]

Nanotechnology is also widely used in pharmacology, starting with the methods of producing the drug, passing through the means of preserving it, and ending with how it is given to the patient in a form that is far superior to current methods. Nanotechnology has surpassed today in research into developing better ways to produce food in various aspects, and to purify water and other things that humans consume. From here, it is possible to imagine the production of a processor the size of a virus that is programmed to pursue and destroy the bacteria that cause a certain disease, which leads to treating diseases that traditional medicine is unable to treat.

One-dimensional nanomaterials:

All materials whose dimensions are less than 100 nanometers fall under this category. This category is called one-dimensional nanomaterials (that is, those that have only one nano dimension). Examples of these materials include thin layers [5, 6], such as nanomaterials used in surface nanocoating works, such as those used in coating the surfaces of metal products to protect them from corrosion by rust, or those thin films used in packaging food products with the aim of protecting them from pollution and damage. . Various semiconductor materials, such as silicon wafers, are also manufactured for use in the manufacture of solar cells

2D Nanomaterials:

In this group of nanomaterials, two dimensions must be less than 100 nanometers. Nanotubes or cylinders, including carbon nanotubes, nanofibers, and nanowires, are important models for this class of materials. It is not surprising that carbon nanotubes were nominated to be used as supporting and strengthening materials for metal molds to raise their hardness values and improve their mechanical properties [7, 8]. In particular, it increases its resistance to collapse, and combines other unique properties, such as superior thermal and electrical conductivity, in addition to its distinguished chemical properties. It is expected that nanotubes and wires will be used in the manufacture of solar cell components, electronic chips, sensors, and microelectronic devices.

3D nanomaterials:

Nano-dimensional spheres, such as nanograins, as well as metal powders and ultra-fine ceramic materials, are examples of this category of important technological materials that are described as ternary materials. Due to its dimensions on the three axes, X, Y, and Z, it is less than 100 nanometers. It is worth noting that this category of three-dimensional nanomaterials, whether in the form of granules or ultra-fine powders, tops the list of global production of nanomaterials in general due to their multiple uses in modern technological fields and applications. For example, nano-grained powders of metal oxides are now available in the market, which are of great economic importance, as metal oxides such as silicon oxide, titanium oxide, aluminum oxide, as well as iron oxides, are used in the electronics industry, building materials, and the paint and paint industry, as well as in the pharmaceutical industry and modern medical devices to replace [9]. This replaces traditional materials, and contributes to raising the efficiency and quality of products. The class of nanograins of free metal elements is Nobel Metals. In particular, gold metal is one of the granular nanomaterials due to its importance and uses in many applications related to defeating and killing cancerous tumors that affect the body's organs [10, 11]. Gold nanoparticles have been used to identify the DNA sequences associated with the disease, as well as to identify the DNA sequences of viruses that invade the human body.

Shapes of nanomaterials

Quantum dots:

It is a three-dimensional semiconductor nanostructure whose dimensions range between (2-10nm) and this corresponds to (10-50) atoms per diameter.

Nano Wires

They are wires with a diameter of less than one nanometer and of different lengths, that is, a length to width ratio of more than (1000) times. They are superior to traditional (three-dimensional) wires [12, 13]. This is because the electrons are confined quantitatively to one side, which makes them occupy energy levels. Specific differs from that of volumetric matter. Nanowires have several shapes, including helical or pentagonal symmetrical.

Nano fibers

Nanofibers have received great attention for their industrial applications, and they have many shapes, such as hexagonal and helical fibers, and among the most famous nanofibers are those made of polymer atoms [14-16]. Nanofibers are characterized by a large surface area-to-volume ratio, as the number of surface atoms is large compared to the total number, which gives them distinct mechanical properties such as hardness, tensile strength, and others.

Nano particles

It is an atomic or molecular accumulation ranging in number from a few atoms to a million atoms, linked together in a spherical shape with a radius of less than (100nm). One of the features of nanoparticles is the possibility of them being suspended inside a liquid or solution without floating or submerging [17]. This is because the interaction between The surface of the particles and the liquid is so strong that it overcomes the density difference between them.

Nano-composites

They are materials to which nanoparticles are added during the preparation of these materials, and as a result, the nanomaterial shows a significant development in the electrical and thermal conductivity features of the material, and the addition of other types of nanoparticles may result in improving the optical properties [18-20] as well as the mechanical properties such as strength and hardness. . One of the most popular nanocomposites now is polymeric nanocomposites

Method of production of nanomaterials

- Spraying method
- Electrodeposition method
- Spray pyrolysis method
- Sol-gel method
- Hydrothermal decomposition method
- Fluid phase pulsed laser ablation method

Pulse Laser Ablation in Liquid Phase (PLAL) Method

Recently, pulsed laser ablation technology has been developed to manufacture nanomaterials, which can be performed in different environments, either in a vacuum or in a liquid environment. PLAL technology has become successful for preparing nanomaterials, leading to diverse fabrication by selecting appropriate solids and liquids compared to other traditional physical methods [21, 22], for example, chemical vapor deposition, pulsed laser ablation, and chemical methods including the hydro- Thermal. The PLAL technique is more effective, as it is possible to avoid aggregation of nanoparticles by using dispersions and ultrasonic vibration, in addition to changing the pH value of the solution. The liquid phase pulsed laser ablation technique has several advantages, including: Simple and clean, the final product is obtained in an easy way without the need for further purification, low cost and easy control of parameters. In addition, it is characterized by the preparation of nanomaterials at low temperatures, the production of more than [23, 24] one material at the same time, and homogeneous and pure compounds. In this technique, a pulsed laser is used to remove a target immersed in a liquid by focusing the laser beam and concentrating it on the target using a lens with a suitable focal length. The ablation process begins with the target absorbing the high laser pulse energy after penetrating the liquid and reaching the sample. The energy absorbed by the sample will be transferred from photons to electrons and then to the lattice, which leads to an increase in the temperature of the surface of the material, and this in turn causes a rapid evaporation process. Plasma is formed as a result of the evaporation process. Which contain different types of particles, such as atoms or vaporized ionized electrons, which have high kinetic energy (that is, a photochemical reaction occurs due to the spread of the high energy of the laser pulse, which works to extract the atoms and molecules from the surface, leading to atomization in the form of a cloud). Plasma plume contains atoms and ions. The product of the chemical reactions that take place between the molecules of the solid and those dissolved in the liquid are nanoparticles (NPs) consisting of atoms of both the target and the liquid, which form a suspension in the liquid. There are several factors that affect the ablation process [24-28]. Lasers include: laser wavelength, laser power, type of liquid medium, depth of optical path of the laser beam inside the liquid, and type of target material.

Laser ablation or photoablation is the process of removing material from a solid (or sometimes liquid) surface by irradiating it with a laser beam. When the laser flux decreases, the material is heated by the absorbed laser energy and evaporates or sublimates. In the case of high laser flux, the material is usually converted into plasma. Laser scraping usually refers to the removal of material using a pulsed laser, but it is possible to scrape the material with a continuous wave laser beam if the laser intensity is high enough. Deep ultraviolet excimer lasers are mainly used for photoabrasion; The wavelength of the laser used in photoabrasion is approximately 200 nanometers.

Applications

The simplest application of laser planing is to remove material from hard surfaces in a controlled manner. Examples include the use of laser machines, especially laser engraving; Pulsed lasers can drill very deep and small holes through very hard materials. Very short laser pulses remove material so quickly [29-31] that the surrounding material absorbs very little heat, so laser engraving can be performed on sensitive or heat-sensitive materials, including tooth enamel (laser dentistry). Many workers have used laser abrasion and gas condensation to produce nanoparticles of metal, metal oxides, and metal carbides.

Importance of Nanotechnology

The importance of nanotechnology lies in the emergence of a new generation of applied materials with distinctive and unique properties, whether on the chemical or physical level.....etc., compared to non-nano materials [32, 33]. All of this came about by arranging matter particles next to each other in a way that we cannot imagine and at the lowest possible cost, which brought us super-performance computers that can be placed on the tips of pens and pins, and also showed us a fleet of medical nano-robots that we can inject into the blood or swallow to treat them. Blood clots, tumors and incurable diseases

Properties of nanomaterials:

The effect of reducing the dimensional measurements of materials, which aims to produce granules with nano-sized dimensions, is positive on all the characteristics of the material and makes it preferable to similar materials through the following:

Mechanical properties:

The mechanical properties of materials come at the top of the properties that benefit from the small size of the particles and the presence of a large number of atoms of the material on its outer surface. For example, the hardness values of metallic materials and their alloys increase, and their resistance to the stresses of the various loads imposed on them increases, by reducing the grain size of the material and controlling the arrangement of its atoms.

Chemical properties:

One of the factors affecting the increase in the chemical activity of nanomaterials is the large surface area of nanoparticles and the presence of a large number of atoms of the material on their outer surfaces, which makes them at the top of the list of materials desirable for use in various chemical applications [34, 35]. One of the most important applied examples of this class of materials is Nanocatalysts, which are composed of ultra-fine grains whose internal diameters do not exceed 100nm. Nanocatalysts interact strongly with harmful gases such as nitrogen oxides resulting from the burning of fossil fuels, whether in electrical transformers. Cars and equipment are likely to play a major role in reducing environmental pollutants in these toxic organic compounds

Physical properties:

The values of the melting temperatures of a substance are affected by reducing the dimensions of its grain scales. For example, the temperature at which gold metal transforms from the solid state to the liquid state is known as the melting point, which is (1064°C). The values of the melting points of gold vary according to the measurement of the dimensions of the diameters of its grains, as they decrease noticeably with the decrease in the diameters of these grains, reaching (500°C) when the diameter of the gold grains decreases to (1.35nm)

Optical properties:

The field of electronics and optics is one of the most important applied fields in nanomaterials, which combine their characteristics with optical properties and superior electrical conductivity, such as gold grains and carbon nanotubes [36, 37]. These materials are used in the manufacture of high-resolution screens, such as television screens and modern computers. Researchers in the field of optics are interested in nanomaterials due to the unprecedented properties that these materials possess. It is interesting that the effect of grain size extends to altering the optical properties of the material, including light scattering of the material’s surface. For example, the color of pure gold grains whose dimensions exceed 200 nm is the well-known yellow color, but when the dimensions of those grains are reduced below 20 nm, they become colorless, and as their dimensions are reduced, they appear in varying colors from green to orange and then red, according to the values of the dimensional measurements of its diameters.

Magnetic properties:

The strength and intensity of the magnet increases as the dimensions of the grains of the material from which it is made become smaller, the area of its outer surface increases, and the presence of atoms on those surfaces. One of the most important sources of materials used in the production of super-strong magnets are nanomaterials with magnetic properties [38], which are used in large electrical generators and motors. Giant ships and ships

Electrical properties:

The small particle sizes of nanomaterials have an effective impact on their electrical properties, which are represented in their superior ability to conduct electrical current. Nanomaterials can now be used in the manufacture of microsensors and electronic chips in various modern devices

Nd-YAG Laser

The Nd-YAG laser is one of the most important solid-state lasers that was discovered in 1964. Its active medium is a YAG crystal.

An Nd-YAG crystal produces a laser whose initial energy is around 1,064 micrometers. When we feed Nd ions into a glass crystal, the laser is produced at a wavelength ranging from 1,054 to 1,062 micrometers, depending on the type of glass used.

The neodymium laser has a four-level energy system and therefore has a lower critical energy than the ruby laser. The lifetime of the upper laser level is relatively large (230 microseconds for Nd-YAG and 320 microseconds in the case of ND-Glass).

In these two types of lasers, the pumping process can be done using a high-intensity flash lamp. This pumping is classified as light pumping or using a diode laser as a pumping source. The use of a diode laser as a pumping source is considered one of the latest innovations introduced in Nd Lasers. Nd-YAG crystal has good optical properties and high thermal conductivity, which can work in the pulsed mode. The crystal size is specific and may reach approximately 0.1 meters in length and 12 mm in diameter. Which leads to determining the energy and power of the output laser. The concentration of neodymium ions reaches 0.725% by weight.

Chlorophyll pigment

It is a green pigment found in the solar systems in the chloroplasts, which gives plants their green color. It also plays an essential role in the process of photosynthesis, which forms the basis of life on Earth [39]. The word chlorophyll is derived from Greek words - “chloros”, which means green, and “phylon”, which means “leaf” (there is no relationship between chlorophyll and the element chlorine). The importance of chloroplasts does not only lie in giving the plant a green color, but we also find that chloroplasts are responsible for the process of photosynthesis in plants, as they convert carbon dioxide present in the air and water into sugar, glucose, and starch through solar light energy, and thus the plant grows and produces fruits. During this process, oxygen is also split from the water molecule and released into the air.

Types of chlorophyll

- The first type is green-blue in color
- The second type, b, is greenish-yellow in color.
- The first is characterized by containing a CH3 group, while chloroplast B contains a CHO group
- There are also types f, d, c and they differ slightly from each other

Its spectral absorption properties

Experiments conducted by scientists on chloroplasts dissolved in water show that they have a great ability to absorb rays with a wavelength between 600 and 800 nanometers. The ability to absorb rays in the wavelength range of about 400 nanometers, and it is called the Soret-Band. The picture shows the ability of chlorophyll a and b to absorb sunlight in different ranges of the spectrum. Between these two bands there is a band in which sunlight is absorbed at a small capacity (between 500 - 600 nanometers), which is why it is called the green gap. From these absorbed spectra, it can be understood why tree leaves containing chloroplasts A and B appear green. Chlorophyll a and b together absorb the blue (400–500 nm) and red (600–700 nm) spectrum [40]. They do not absorb the green spectrum of rays, and thus the green color is reflected from the leaves, so they appear green. Chloroplasts are found in chloroplasts in plants and in some protozoa.

Tellurium element Te

Tellurium is a chemical element whose symbol is (Te) and is part of “chalcogen” and “elements of the fifth period.” Its atomic weight is “52,” its mass is “127.6,” and its density is “6.24.” It is a semi-metal, brittle, silver-gray in color, and resembles tin. Tellurium is a brittle, slightly toxic, rare element. It is a silvery-white nonmetal. Tellurium is chemically related to selenium and sulfur, all three chalcogens. It is sometimes found in pristine form as elemental crystals. Tellurium is much more common in the universe as a whole than on Earth. Its extreme rarity in the Earth's crust, comparable to platinum, is partly due to its formation of volatile hydride that caused tellurium to be lost to space as a gas during the formation of the Earth's hot nebula.

Discover it

Tellurium (Latin tellus meaning "earth") was discovered in the 18th century in gold ore from mines at Kleinschlatten (today's Zlatna), near today's city of Alba Iulia, Romania. This ore was known as "white paper gold ore." In 1782, Franz Josef Müller von Reichenstein, who was Austria's chief inspector of mines in Transylvania, concluded that the ore did not contain antimony but did contain bismuth sulphide. The following year, it was reported that this was false and that the ore contained mostly gold and an unknown metal very similar to antimony. After an exhaustive investigation lasting three years and including more than fifty tests, Müller determined the specific gravity of the metal and observed that when heated, the new metal emits white smoke with a horseradish-like odor; It imparts a red color to sulfuric acid; When this solution is diluted with water, it produces black deposits

Uses of Te

Tellurium is a semiconductor that shows greater conductivity of electricity in certain directions or when exposed to light. Tellurium is mostly used to improve the machinability of copper and stainless steel. It is also used in the manufacture of explosive capsules, it is also added to cast iron and is used in the ceramic industry. Adding tellurium to lead improves the strength and hardness of the metal and reduces corrosion. Many thermoelectric devices are made using bismuth telluride. Lead telluride is used in infrared detectors It is a gas with a garlic-like odor that is inhaled into the breaths of victims of tellurium exposure or poisoning

Properties of tellurium

- **Physical properties**

Tellurium has two types of allotropes, crystalline and amorphous. When tellurium is crystalline, it is silvery white with a metallic luster. The crystals are trigonal and chiral (space group 152 or 154 depending on Chiraletti), like the gray form of selenium. It is a brittle metal and easily crushed. Amorphous tellurium is a brown black powder prepared by precipitation from a solution of telluric acid or telluric acid (Te(OH)6).[11] Tellurium is a semiconductor that exhibits greater electrical conductivity in certain directions depending on atomic alignment; The conductivity increases slightly when exposed to light (photoconductivity). When melted, tellurium is corrosive to copper, iron, and stainless steel. Among the chalcogens (oxygen family elements), tellurium has the highest melting and boiling points, at 722.66 K (449.51 °C) and 1,261 (988 °C), respectively.

- **Chemical properties**

Crystalline tellurium consists of parallel helical chains of Te atoms, with three atoms at each turn. This gray material resists oxidation by air and is non-volatile

Applications

The largest consumer of tellurium is metallurgy in iron, stainless steel, copper and lead alloys. Adding steel and copper produces an alloy that is more processable than otherwise. It is converted into cast iron alloys to enhance coldness for spectroscopic analysis, as the presence of free electrically conductive graphite tends to interfere with spark emission test results. In lead, tellurium improves strength and toughness, and reduces the corrosive effect of sulfuric acid.

Materials and Methods:

Preparation of tellurium Te tablet

In this research, tellurium (Te) powder of high purity (99.99%) was used after being pressed into pellets of a certain thickness. For each tablet, (6 gm) of powder was weighed and placed inside a cylinder made of stainless steel after cleaning it with ethanol, and pressing was done using a compressive strength testing device, type JB/T3818-1999, with a compressive force of (2 MPa). After that, the heat-pressed sample was processed by placing it in an electric oven using a drying oven, type WG43, for 24 hours in order to obtain a cohesive material for the sample and to get rid of the breakage of the discs after shining a laser beam on them.

Laser ablation system

The figure shows a pulsed laser device for ablation of colloidal nanoparticles of a solid target immersed in different solutions. It consists of a laser source (Q-Switch Nd:YAG laser) with a wavelength of (1064nm), with second harmonic generation (532nm), and third harmonic generation (355nm).

Preparation of Te/chlorophyll nanocomposite using pulsed laser ablation in liquids technique

Colloidal Te/chlorophyll solutions were prepared by laser fragmentation of a solid Te target in a solution (water). The target (Te) was placed in a glass container filled with (4ml) of water. After that, the target was irradiated with a number of pulses (500Pluses) using an Nd laser. Pulsed YAG: wavelength 1064nm, frequency 6Hz, pulse width 10ns, and energy 80 millijoules per pulse.

After that, the samples were prepared by depositing the materials resulting from the laser fragmentation process onto glass slides after cleaning them and washing them using distilled water and alcohol, and drying them well by placing them in an electric oven at a temperature of (46°C) for (10) minutes, using cleaning paper. Specially designed to be ready for use for the purpose of performing UV_FTIR measurements

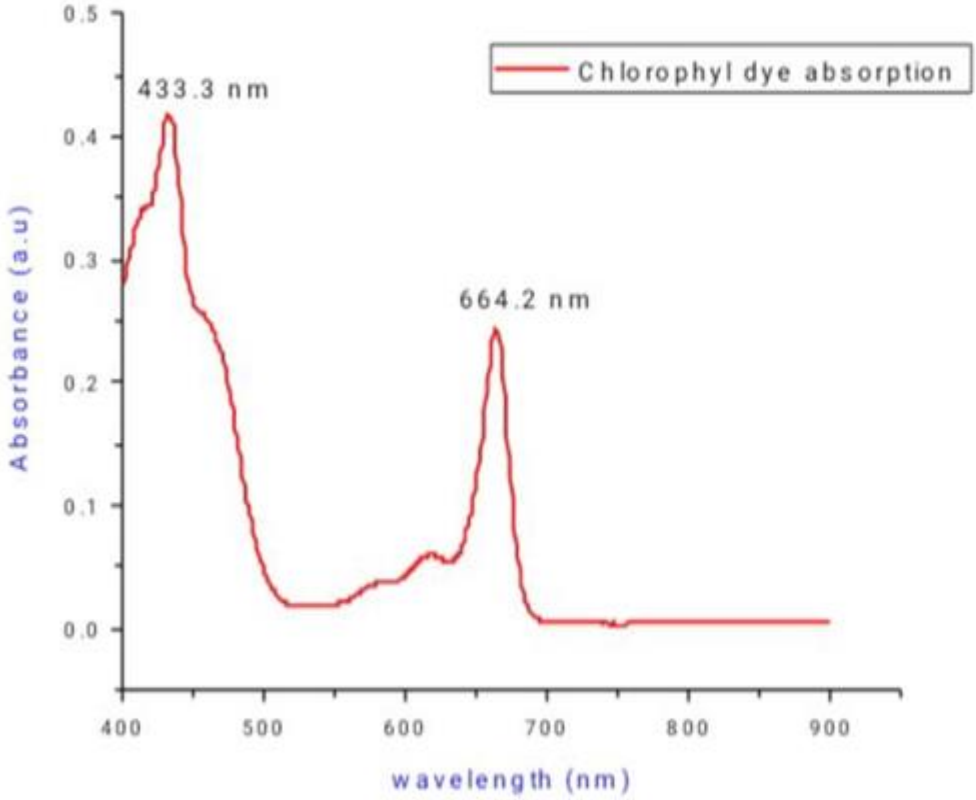
Measuring devices

UV-Visible spectroscopy

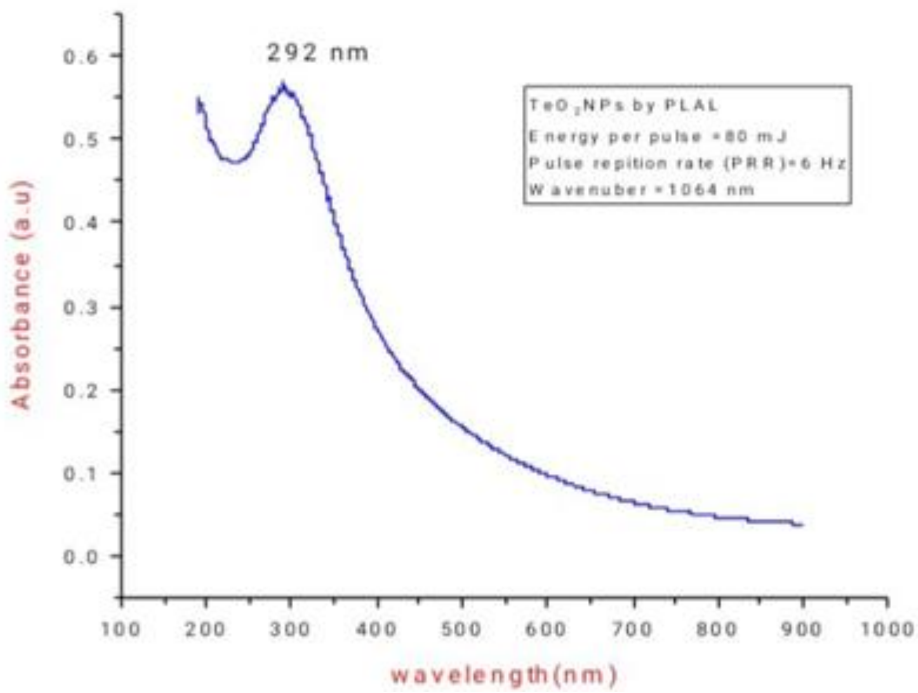
The absorption spectra of the Te/Chlorophyll nanocomposite solutions were measured using a dual-beam UV-Visible spectroscopy, type (CECIL CE 7200) (ENGLAND), where the solutions were placed in a quartz container after performing the calibration process and zeroing the device. After that, Excel equations were used to find the optical parameters using a computer, which are absorbance and optical energy gap. Most of the devices that are used in spectroscopic analysis methods in the field of visible rays are the same used in spectroscopic analysis methods in the field of ultraviolet rays, so they are usually studied together. Also, visible light behaves like ultraviolet light in many of its manifestations, as both of them result from their absorption by electronic excitation in molecules. These two spectra cover the range from (190nm-1100nm).

Devices:

Instrument	sCompany	Work place
Q-Swiched Nd – YAG laser	China	Collage of science for woman, Babylon University
UV-Vis Spectrophotometer	Japan	Collage of science for woman, Babylon University
X- Ray Diffraction (XRD)	Japan	Collage of Engineering , University of Kufa
Fourier Transform Infrared Spectrophotometer (FTIR)	Germany	Collage of science for woman, Babylon University
Energy Dispersive X-ray (EDX)	Japan	The University of Shahid Bahshte ,Tehran , Iran
Field Emission Scanning Electron Microscopy(FE-SEM)	USA	The University of Shahid Bahshte ,Tehran , Iran
Ultracentrifuge	Taiwan	Collage of science for woman, Babylon University
Magnetic stirrer	Iraqi	Collage of science for woman, Babylon University
Oven	China	Collage of science for woman, Babylon University
Ultrasonic Bath	China	Collage of science for woman, Babylon University



We notice from the drawing that there are two peaks of absorption: 433.3 (nm) and 664.2 (nm) in the visible range. It has many uses in solar cells, and its importance increases when used or mixed with other materials like it.



The second drawing shows the absorption spectrum at the peak (292nm) in the ultraviolet region. This peak indicates the formation of the nanomaterial trillium.

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