GREEN SYNTHESIS OF TITANIUM DIOXIDE NANO PARTICLE USING ZIZIPHUS MAURITIANA (INDIAN JUJUBE) LEAF EXTRACT AND STUDY ON ITS STRUCTURAL, OPTICAL AND MORPHOLOGICAL PROPERTIES

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Abstract:

Nowadays most of the research based on the nontoxic green synthesis of titanium nanoparticles using plant extracts. This ecofriendly titanium nanoparticles exhibit completely new or improved properties based on specific characteristics such as size, distribution, morphology and many applications. In this research the synthesis of titanium dioxide nanoparticles using plant zizuphus mauritiana has been investigated. We have synthesized nanoparticles by adding the 100ml of titanium oxide solution into the plant extract and characterized by uv-visible absorption spectroscopy, Fourier transform infrared spectroscopy (FTIR), X Ray Diffraction (XRD) and SEM techniques. This techniques showed that the size and also it revealed the structure.

Introduction:

Nanotechnology is a branch of science which deals with the manipulating matter on an atomic or molecular scale. These material handling the size less than 100nm. Nowadays nano science is an essential for optics, electronics, mechanical science, drug delivery, chemical industries, Bio medical field, Energy science, catalysis, Photo electric chemical applications**.** Titanium Oxide Attracts due to its physical and chemical properties, excellent material for optical, high thermal and chemical stability and Eco-friendly or Non toxic. TiO_2 is widely used for the products like skin cosmetics, food colours, inks, toothpaste, textiles, papers etc., Green chemistry approach is significant for the future prospect of nanomaterials. This field of nano science should culminate in the development of pollution free, safe NPs and should have wide acceptance in the nanotechnology.

Key Words

Nanoparticles, green synthesis, Ziziphus mauritiana, Green treatment.

Materials and methodology

Materials

Ziziphus mauritiana leaves were collected from the Field located in Dindigul district. Titanium dioxide was purchased from the authorized laboratory centre. The experiment was conducted at Sakthi Educational Institutions in oddanchatram at

Dindigul district. All chemicals and reagents are of analytic grade and used without further purification.

Ziziphus mauritiana

Ziziphus mauritiana is generally known as Indian Jujube, Indian plum and Chinese date. It is a tropical fruit tree belongs to the rhamnaceae. It is a spiny, evergreen and small tree height up to 15m. The fruit is edible which is rich in vitamin C. The leaves are readily eaten by camels, cattle and goats and are consider as nutritious. The leaves used treat liver troubles, fever and asthma .and helps in relieve joint pain, dandruff, acne, chronic constipation, antiseptic, sedative, hypnotic and cardiac diseases.

Methodology

Preparation of *ziziphus mauritiana* leaf extract

The thorns of *Ziziphus mauritiana* were removed by using scissor and needles and then the leaves were washed with distilled water to remove contaminants present on the leaf surface. The distilled water found on the leaf surface is dried at the room temperature by using dryer. The leaves were cut into small pieces. 50g of leaves was added with 100ml of distilled Water kept under the magnetic stirrer with hot plate for 3 hrs at 40℃. After the colour change, the extract was filtered at 20-21℃ by using Whatman Filter paper. The extract is stored at 20℃ in the freezer for further utilization and future reference.

Synthesis of titanium dioxide Solution

In order to synthesize TiO_2 nanoparticles, 1.0 N of Titanium Chloride is dissolved in the 100 ml of distilled water. Add leaves extract drop wise under constant stirring for 5 hours continuously. This process resulted in the formation of nanoparticle and it was separated by using whatman filter paper. The filtered residues containing nanoparticle was washed with water repeatly to remove derivatives of it. The nanoparticles were dried for overnight and calcined at 500℃ for 4 hours.

Characterization techniques

The prepared green based TiO_2 nanoparticles were characterised by using UV-visible spectroscopy, FT-IR and SEM. We absorbed the UV-Visible spectrum range from 300-800nm. The FT-IR spectroscopy is used to record the FT-IR spectrum of at a resolution of 4cm. The SEM is used to Analyse the shape and of molecule.

Ultra violet visible spectroscopy

UV Spectroscopy uses ultraviolet light to determine the absorbency of a substance. In simple terms, the technique maps the interaction between light and matter and measures. As matter absorbs light it undergoes either excitation or de-excitation, which generates what is known as a spectrum. This allows scientists to measure the rate at which a beam of light weakens after passing through a substance**.**

Fourier Transform infrared spectroscopy

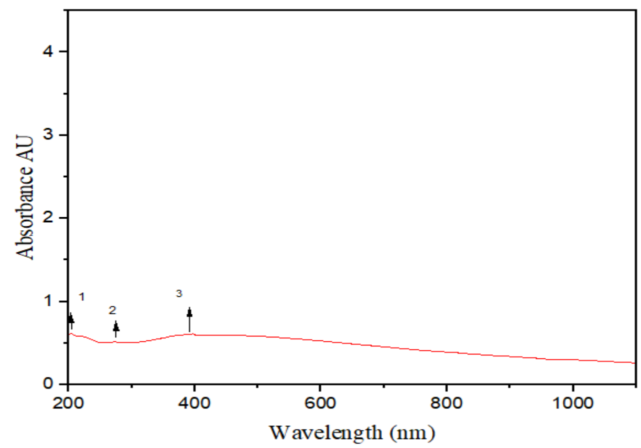
Fourier transform infrared spectroscopy (FTIR) is a largely used technique to identify the functional groups in the materials (gas, liquid, and solid) by using the beam of infrared radiations. An infrared spectroscopy measured the absorption of IR radiation made by each bond in the molecule and as a result gives spectrum which is commonly designated as % transmittance versus wave number (cm^{-1}). A diverse range of materials containing the covalent bond absorbed electromagnetic radiation.

Scanning electron microscope

A scanning electron microscope (SEM) projects and scans a focused stream of electrons over a surface to create an image. The electrons in the beam interact with the sample, thereby producing various signals that can be used to obtain information about the surface's topography and composition. In order to form an image the receiving signals produced from the electron sample interactions are detected with different types of detectors depending on the mode of SEM being used. Different modes of SEM exist for characterization of materials such as the X-ray mapping, secondary electrons imaging, backscattered electrons imaging, electron channeling, and Auger electron microscopy.

Results and discussion

UV visible spectroscopy



The uv visible light at wavelength ranging from 200-800 nm was used to evaluate the light absorption chracteristics of Tio2 nanoparticles.The UV visible spectra of Tio2 and leaf extract in an aqueous solution at room temperature.The absorption peaks obtained for the samples in the range of 203.25 nm for titanium dioxide. For the peak 289.75nm the corresponding absorption range is 0.6139AU.

The conduction band energy is calculated from the Einstein's photon energy equations.

$$E=hc/\lambda \text{ max}$$

Where,

λ max- maximum absorbance wavelength

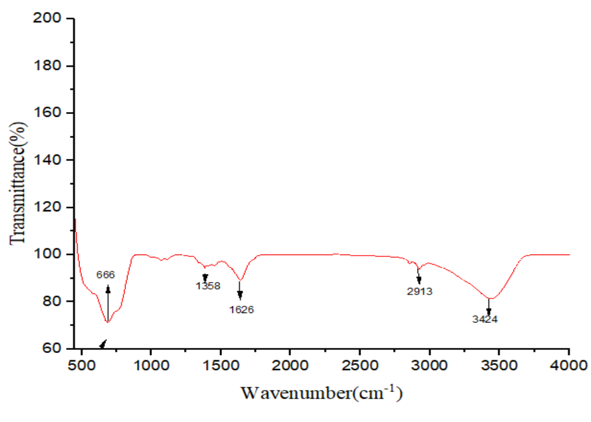
H-Planks constant

C-speed of light

The band gap energy of titanium dioxide has been calculated to be 3.12ev.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Fourier transform infrared (FTIR) spectroscopy

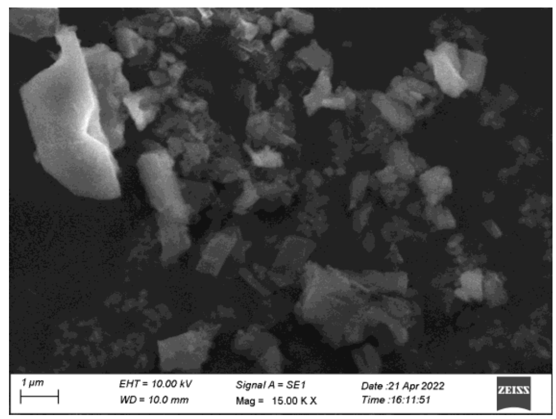


FTIR Graph of TiO_2

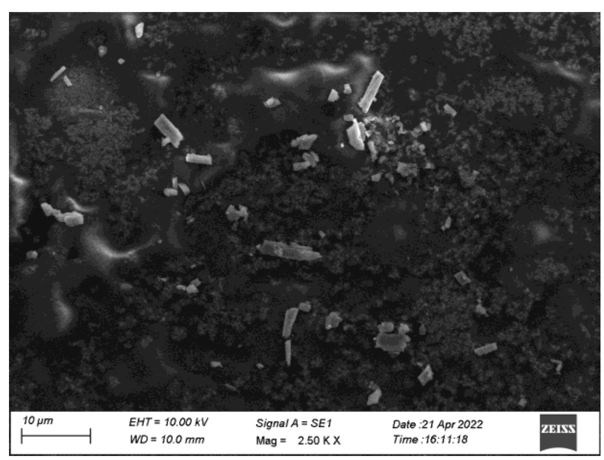
Fourier-transform infrared (FT-IR) spectra were recorded using an FT-IR spectrophotometer. FTIR spectroscopy is used to study the change in chemical composition, impurity content and interaction between different species. FTIR spectrum is used to calculate various functional groups which present in the TiO2 nanoparticles and also used to determine the absorption range. The FTR spectra of the TiO2 nanoparticles which were synthesized by precipitation method. The wave number at 666.0 cm^{-1} represent the stretching vibration C-I(strong). The wavenumber at 1358.0 cm^{-1} represents stretching vibration O-H(Strong). The wavenumber at 1626.0 cm^{-1} represents stretching vibration C-C (Medium). The wavenumber at 2913.0 cm^{-1} represents stretching vibration C-H (Medium). The wave number at 3424.0 cm^{-1} represents Stretching vibration O-H (Strong).

Scanning electron microscopy

scanning electron microscopy techniques, provides information on the size, shape, location of the individual nanoparticles. Scanning electron microscopy analysis was employed to study the morphology of the nanoparticles. The SEM image shown in figure a. It can be seen that TiO2 nanoparticles were exclusively Rod shape.

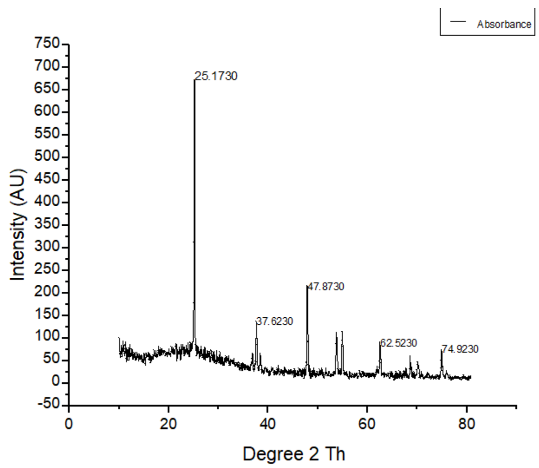


SEM image of TiO2 for 1μm



SEM images of TiO2 10μm

X RAY DIFFRACTION



Using X ray diffraction phase analysis was studied. The average crystalline size of the nanoparticles were calculated based on Debye' scherer's equation.

$$D=K\lambda/\beta cos\theta$$

D=Mean crystalline size

K=Shape facters taken as 0.94

λ=Wavelegth of the incident beam

β=Full width half maximum

Ɵ=Bragg's law

The obtained structure was compared with TCPDS data. The synthesized Tio2 sample shows 5 major peaks 25.1609, 37.6648, 47.9052, 62.5214, 74.8872 respectively. The below table shows then the interplanar distances and FWHM of corresponding 2Ɵ values of Tio2 nanoparticles. The average or estimated crystalline size is about 2.12nm.

Conclusion

In this current Experiment, The TiO2 nanoparticles were successfully synthesized using *Ziziphus mauritiana* leaf extract as a reducing agent and the obtained nanoparticles were chracterized to evaluate physical, chemical, structural and morphological behavior.

Present method of green synthesis proved to be useful in controlling the size of TiO2 nanoparticles, thereby tuning their catalytic properties.TiO2 nanoparticles was successfully synthesized by using ball milling method. TiO2 nanoparticles were exclusively Rod shape detecting by Scanning Electron Microscopy. The absorption peaks obtained for the samples in the range of 203.25 nm for titanium dioxide. For the peak 289.75nm the corresponding absorption range is 0.6139AU. Functional groups of nanoparticles were absorbed by FTIR Analysis. UV visible spectral analysis of Tio2 nanoparticles absorption peak in UV region 200-800nm. The above results Indicates that The ZMTiO_2 nanoparticles can acts as an effective photocatalytic material towards the degradation of organic molecules.

References

1)Zhu, J.; Zhang, J.; Chen, F.; Iino, K.; Anpo, M. High activity TiO2 Photocatalysts Prepared by a Modified Sol–gel Method: Characterization and their Photocatalytic Activity for the Degradation of XRG and X-GL. Top. Catal. 2005, 35, 261–268. [CrossRef] 39. Ramimoghadam, D.; Bagheri, S.; Abd Hamid, S.B. Biotemplated Synthesis of Anatase Titanium Dioxide Nanoparticles via Lignocellulosic Waste Material. Biomed. Res. Int. 2014, 2014, 1–7. [CrossRef] 40. He, J.; Du, Y.; Bai, Y.; An, J.; Cai, X.; Chen, Y.; Wang, P.; Yang, X.; Feng, Q. Facile Formation of Anatase/Rutile TiO2 Nanocomposites with Enhanced Photocatalytic Activity. Molecules 2019, 24, 2996.

2)Abdel-Halim S.H., Shehata A.M., El-Shahat M.F., Removal of lead ions from industrial waste water by different types of natural materials. Water Res., 2003, 37, 1678-1683.10.1016/S0043-1354(02)00554-7Search in Google Scholar

3) Mondal M.K., Removal of Pb (II) ions from aqueous solution using activated tea waste: Adsorption on a fixed-bed column. J. Environ. Manage., 2009, 90, 3266-3271.10.1016/j.jenvman.2009.05.025

4) Chawla, V.; Sathaye, S. Biosynthesis of silver nanoparticles using methanolic extracts of Acorus calamus, and assessment of its antioxidant and antimicrobial activity. J. Med. Plants Stud. 2017, 5, 358–363. 49.

5) Ganesan, R.; Gurumallesh Prabu, H. Synthesis of gold nanoparticles using herbal Acorus calamus rhizome extract and coating on cotton fabric for antibacterial and UV blocking applications. Arab. J. Chem. 2019, 12, 2166–2174.

6) Dubey, R.S.; Krishnamurthy, K.V.; Singh, S. Experimental studies of TiO2 nanoparticles synthesized by solgel and solvothermal routes for DSSCs application. Results Phys. 2019, 14, 102390.

7) Natarajan, K.; Natarajan, T.S.; Bajaj, H.C.; Tayade, R.J. Photocatalytic reactor based on UV-LED/TiO2 coated quartz tube for degradation of dyes. Chem. Eng. J. 2011, 178, 40–49. [CrossRef]

8) Tayade, R.J.; Natarajan, T.S.; Bajaj, H.C. Photocatalytic Degradation of Methylene Blue Dye Using Ultraviolet Light Emitting

9) Nanoparticles: structure, properties, preparation and behaviour
in environmental media P. Christian Æ F. Von der Kammer Æ M. Baalousha Æ Th. Hofmann

10) Application of Green Silver Nanoparticles Synthesized using Leaf Extract of *Tridax procumbens* for Preparation of Clinical

Antimicrobial Bandages Vitthal Chopade*,
Diksha Kamble
Department of Pharmaceutical Quality Assurance,
Modern College of Pharmacy, SPPU, Pune,
Maharashtra, INDIA.

11) Heuzé V., Tran G., Boval M., Lebas F., 2017. Indian jujube (Ziziphus mauritiana). Feedipedia, a programme by INRA, CIRAD, AFZand FAO. https://www.feedipedia.org/node/80

12) ^ "Ziziphus mauritiana (tree, shrub)". Invasive Species Specialist Group. 2007-02-14. Retrieved 2009-07-17.

13) singh et al.2019