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Preparation and Characterization of Titanium Dioxide Nanoparticles using *Salvia Rosmarinus* Extract

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ABSTRACT

Titanium dioxide (TiO₂), one of the most frequently used materials in general, has emerged as an excellent photocatalytic material for environmental applications. In this research work, we focused on the green synthesis of titanium dioxide nanoparticles using Algerian *Salvia Rosmarinus* extract. The leaf extract of this plant was prepared by the maceration extraction method and the synthesis of TiO₂ NPs was obtained using a suitable protocol followed by calcination and activation at a temperature of 500°C. Physicochemical properties of TiO₂ nanoparticles were characterized with UV Visible spectrum, attenuated total reflection infrared (ATR-IR) and zetametry analysis. The photocatalytic activity of these synthesized nanoparticles will be tested using different pollutants.

Keywords: Green synthesis, plant extract, titanium dioxide nanoparticles, photocatalysis, water treatment

1 Introduction

Titanium dioxide is the most frequently used photocatalyst for water and air purification. It is relatively cheap and abundant. It is non-toxic, insoluble in water and resistant to most chemicals, such as acids, bases, or solvents [1]. Titanium dioxide NPs can be synthesized using a variety of methods. Green synthesis of titanium dioxide NPs has gained wide attention among scholars due to its cost-effective, eco-friendly, and reproducible method. The green synthesis method of nanoparticles using plants has many benefits, one of which is the elimination of the need for chemical stabilizing agents. Plant extracts can act as both reducing agents and stabilizers at the same time, and such a method also reduces the use of various chemical substances and makes use of natural substances, which further lowers the toxicity level of TiO₂ nanoparticles [2].

2 Research Methodology

Preparation of plant extract:

- Plant used for the green synthesis of TiO₂ nanoparticles is *Salvia Rosmarinus*.
- The plant was collected at the VRMDD laboratory at USTHB.
- Fresh leaves of *Salvia rosmarinus* were washed, dried and ground to a fine powder.
- This plant powder was used to prepare the extract by the maceration extraction method:
- About 5 g of *Salvia Rosmarinus* powder were boiled for 1 hour in deionized water (100 ml) at 70 °C. The plant extract was filtered using Whatman filter paper.

Green Synthesis of TiO₂ NP:

A solution of titanium tetraisopropoxide or TTIP was prepared in 100 ml of deionised water and the green tea leaf extract was added under constant stirring. The NPs formed during the process were collected and washed several times with distilled water and dried at 100°C overnight and then calcined at 500°C for evaluation in water treatment.



3 Results and Discussion

Green Synthesis of TiO₂ NP

TiO₂ NPs were well synthesized using *Salvia Rosmarinus* extract. For 5 g of ground green tea leaves, environ 0.5 g of nanoparticles were obtained.

Characterisation of TiO₂ NP Synthesised at 500°C

Several physicochemical analyses were carried out (UV Visible, ATR-IF and Zetametry analysis). Here we present the ATR IR results.

- **Attenuated total reflection infrared (ATR-IR)**

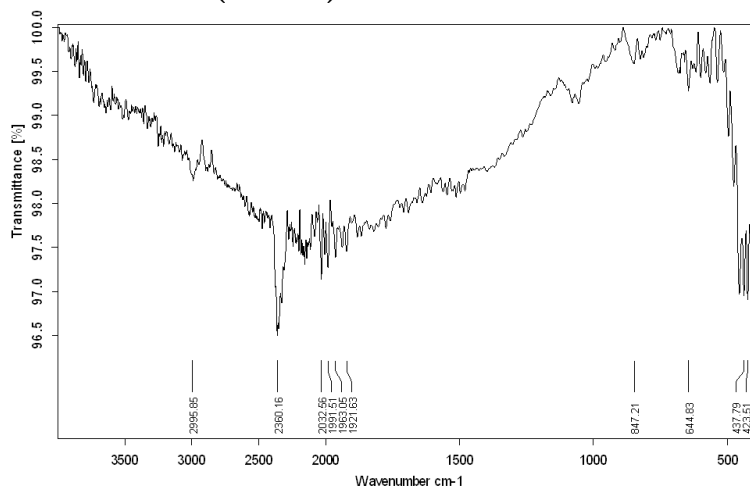


Figure 1: ATR-IR plot of synthesized TiO₂ NPs

The FTIR spectrum of the synthesized TiO₂ nanoparticles showed various characteristic peaks as shown in Fig. 1. The strong absorption peak in the range of 850–400 cm⁻¹ was attributed to the stretching band of the O–Ti–O bond. Peaks close to 2000 cm⁻¹ is attributed to C–H bending indicated the involvement of intermediate form of the phenolic group in the process. The peak at 2360.16 cm⁻¹ is related to adsorption of atmospheric CO₂ on the surface of NPs. The vibrational band at 2995.85 is related to the hydroxyl group (O–H group) of the water molecule’s intermolecular interaction with the surface of TiO₂ [2].

4 Conclusions

The TiO₂ nanoparticles were successfully synthesized by the green synthesis method using *Salvia Rosmarinus* leaf extract at 500°C. The TiO₂ nanoparticles synthesized at 500°C were characterized by ATR-IR technique. ATR-IR analyses confirmed the formation of Titanium dioxide nanoparticles. Further analysis will be carried out to analyse their morphological, structural, granulometric, surface and optical properties like XRD, SEM and BET. These nanoparticles will be evaluated and tested in wastewater treatment and environmental applications.

References

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