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Biological Synthesis of ZrO_2 Nanoparticle Using Azadirachta Indica Leaf Extract

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Abstract: *In this paper, we have synthesized and characterized Zirconium dioxide nanoparticle (ZrO2) which is one of the inorganic nanoparticles. ZrO2 nanoparticles are successfully prepared by green syntheses, one of the ways of biological method.* Azadirachta indica *leaves are used first time to synthesis ZrO2 nanoparticles. The prepared nanoparticles are characterized by UV-Vis spectroscopy. Band gap was calculated about 5.80eV and this value was good of result with the referred paper [2].*

Keywords: ZrO2, nanoparticles, Azadirachta indica, green synthesis, Band gap.

1. INTRODUCTION

Nanoscience is the research in the nanometer scale commonly indicated as (1-100nm). Nanotechnology work at the atomic, molecular or macromolecular level to maintain the object in the nanometer scale [9]. Nanomaterial is one of the broad fields of Nanotechnology. Properties of these materials are different from the customary ones [3]. Synthesized nanomaterials are organic and inorganic materials for advanced application. Inorganic nanoparticles have significant application in medicine, catalysts, ceramics and food industry. There are different types of inorganic materials, Zirconia also known as zirconium dioxide (ZrO_2) is widely used in different area of chemistry due to their admirable properties. In recent year, ZrO_2 nanoparticles are widely used in oxygen sensor, fuel cell, transparent optical devices, and fire retarding materials, because of their extensive optical, electrical, thermal and chemical properties [2]. At atmospheric pressure, ZrO_2 is derived in multiple forms Monoclinic below 1170°C, tetragonal lie in the range (1170°C - 2370°C) and cubic above 2370°C and melting form at 2706°C [6].Nanomaterial formed by three procedure physical, chemical and biological method. Physical method sub-divided into mechanical and vapour deposition method. Chemical method consist sol-gel, hydrothermal, precipitate and co-precipitate etc. Among chemical method hydrothermal synthesis produce fine, high purity and stoichiometric powder [3]. Biological synthesis used green leaf extract, fungi and bacteria growth as a reducing agent for preparation of nanoparticles. Numerous leaves extract are used like Nyctanthes arbor-tristis leaf, Cymbopogon, aloe Vera, Phyllanthus emblica which follow green chemistry principle [10]. In this paper, we have synthesized ZrO_2 nanopowder by eco-friendly method using green synthesis.

2. MATERIAL AND METHOD

To synthesize the ZrO_2 nanoparticles, we have used Zirconyl chloride octahydrate ($ZrOcl_2.8H_2O$), distilled ethanol, azadirachta indica (neem) leaf powder as a reagent. To prepare ethanolic azadirachta indica leaf extract 100ml of ethanol and 10gm of leaf powder was boiled at 50°C. Now prepared solution was filtered by whatman filter paper. Filtered 10ml of ethanolic leaf extract and 0.5mole of $ZrOcl_2.8H_2O$ was stirred by magnetic stirrer and maintained at 50-60°C temperature. Disembodied ZrO_2 nano size particle were dried in oven at 120°C until we obtained dry powder. Finally dry powder was calcinated to 5-6 hours in muffle furnace at 600°C.

3. RESULT AND DISCUSSION

To confirm nanoparticles, various methods are used such as XRD, UV-Vis spectroscopy, SEM, TEM out of which we have used UV-Vis spectroscopy. The most effective property of nanoparticle is the size transformation of the optical absorption spectra [2]. UV-Vis spectroscopy was also used to determine band gap and particle size (effective mass approximation technique).The UV-Vis

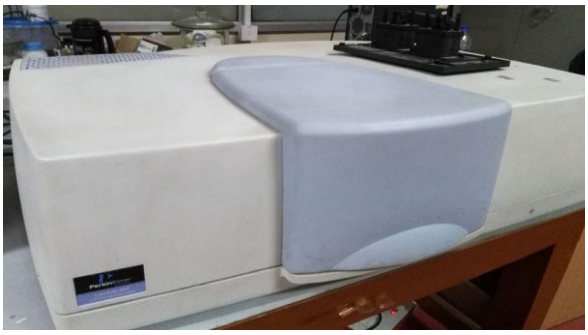
UVB (280-320nm) UV Burning ray, medium wave mostly absorbed by ozone layer.

UVA (320-400nm) UV Aging ray, long wave also called black light not absorbed by ozone layer [2].

We have used UVC to UVA for characterization of ZrO_2 nanoparticles. Absorption peak observed at 214cm^{-1}. Band gap is calculated by:

$$E = \frac{hc}{\lambda}$$

Where E is band gap energy, h is planks constant whose value 6.626×10^{-34} joules sec, c speed of light 3.0×10^{8} meter/sec, λ is cutoff wavelength. The band gap calculated was 5.80 eV consider the value of λ was 214cm^{-1} from fig.2.



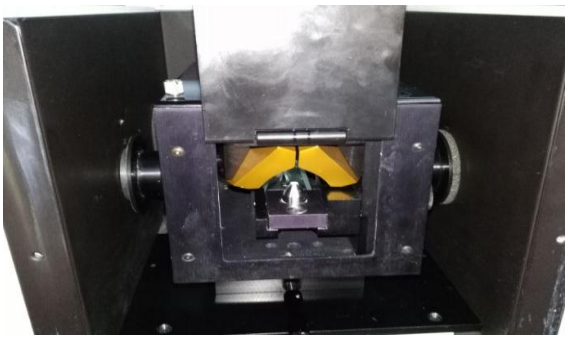


Fig 1. UV-Vis spectroscopy (Perkin Elmer lambda 950 from UGC-DAE consortium for scientific research, Indore)

spectroscopy are used in the range of 100-900nm. The UV spectrums start from 100nm and terminate at 400nm and divided into 4 parts:
UVV (100-200nm) Vacuum ultraviolet, strongly absorbed by atmospheric oxygen and can propagate through nitrogen.

UVC (200-280nm) short wave completely absorbed by atmosphere and the ozone layer.

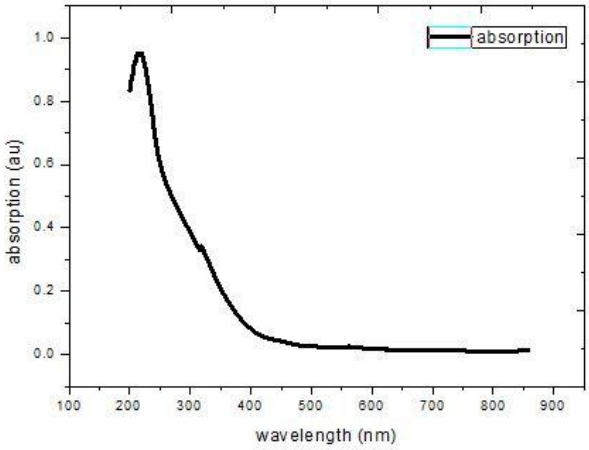


Fig 2 UV-Vis absorption spectra of nano ZrO_2

4. CONCLUSION

In summary, ZrO_2 nanoparticles were obtained by eco-friendly green synthesis method. Azadirachta indica leaf extract was used as reducing agent as well as capping agent. Green syntheses have advantages over other methods due to its cost-effective, simple, and relatively reproducibility. Finally ZrO_2 nanopowder was formed after calcination at 600°C. Nanopowders were successfully studied by UV-Vis spectroscopy and the band gap was calculated as 5.80 eV which was larger than the bulk band gap which is about 5eV.

5. FUTURE SCOPE

Future works are to synthesized ZrO_2 nanoparticle by chemical method and compare the result with this green synthesis method. XRD characterization for crystal phase analysis also done in future.

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