A Review on Preparation, Characterization and Application of Zinc Oxide (ZnO) Nanoparticles by Green Synthesis Method

Sagar B. Raut\textsuperscript{1}, Dr. P.V. Thorat\textsuperscript{2}

\textsuperscript{1}M.Tech. student, Department of Chemical Engineering, College of Engineering & Tech., Babhulgaon, Akola, India
\textsuperscript{2}Head Of Department of Chemical Engineering, College of Engineering & Tech., Babhulgaon, Akola, India

\textbf{Abstract}—Zinc oxide is a multipurpose material because its unique physical and chemical properties like antibacterial & deodorizing property, high piezoelectricity, large binding energy. ZnO nanoparticles has many application in various industries like pharmaceutical, textile, paint, rubber industries. The green method of synthesis of nanoparticles is simple, not expensive, and eco-friendly in comparison to traditional synthesis. The traditional synthesis require high pressure-temperature, hazardous solvents. Green synthesis is new way to the synthesis of nanoparticles.

\textbf{Keywords}— Calotropis Gigantea, Green synthesis, Scanning Electron Microscope, X-Ray Diffraction, ZnO applications.

\textbf{I. INTRODUCTION}

Zinc oxide is an inorganic compound means inorganic compounds are typically compounds without carbon atoms having formula ZnO. It is insoluble in water and appears as a white powder. In material science, ZnO is also called wide bandgap semiconductor. This semiconductor has many properties like strong room temperature luminescence, wide band gap, high electron mobility, good transparency etc. ZnO many properties applicable in liquid crystal displays, heat resisting windows, transparent electrodes. Because of piezoelectric, wide band gap, thermal and chemical stability properties ZnO has electronic applications like drug delivery, biosensor, thin-film transistor, light-emitting diode, gas sensor, solar cell, actuators, and so on. The Fig.1 shows the hexagonal wurtzite structure of ZnO. The tetrahedral coordination of Zn-O is shown. O atoms are shown as larger white spheres while the Zn atoms are smaller brown spheres. And the Table I shows the physical and chemical properties of zinc oxide.

\begin{table}[h]
\centering
\caption{Properties of Zinc Oxide}
\begin{tabular}{|l|l|}
\hline
Property & Value \\
\hline
Molar Mass & 81.408 g/mol \\
\hline
Odor & odorless \\
\hline
Density & 5.606 g/cm\textsuperscript{3} \\
\hline
Melting Point & 1975 °C (decomposes) \\
\hline
Boiling Point & 2360 °C \\
\hline
Solubility In Water & 0.16 mg/100 ml (30 °C) \\
\hline
Band Gap & 3.3 eV \\
\hline
Refractive Index(n\textsubscript{D}) & 2.0041 \\
\hline
\end{tabular}
\end{table}
II. LITERATURE REVIEW

J. Sivakumar et.al. worked on biosynthesis of silver nanoparticles from AgNO₃ solution and using calotrophis gigantean leaf. In biosynthesis method calotrophis gigantean leaf acted as a reducing agent. The synthesized silver nanoparticles were characterized by using UV, SEM, XRD, FTIR testing method.

Maribel et.al. worked on Chemical reduction method for preparation silver nanoparticles and also studied their antibacterial activity. In this method, they utilized citrate of sodium and hydrazine hydrate as a reducing agent. The silver nanoparticles shows antibacterial activity against bacteria like Staphylococcus aureus, Escherichia Coli etc.

M. Vafaee et.al. worked on synthesis and characterization of zinc oxide nanoparticles using sol-gel method. By using this method they synthesized spherical shape ZnO nanoparticles. They utilized first time triethanolamine as a surfactant.

D. Yiamsawas et.al. prepared zinc oxide nanostructures by using solvothermal method. They utilized PVP, ethanol, and zinc acetate dehydrate. All this chemical treated in sealed polypropylene vessel heated in autoclave.

III. MATERIAL AND METHOD

The raw material used are zinc nitrate, Calotropis Gigantea leaves, distilled water, filter paper.

A. Zinc Nitrate

Zinc nitrate is an inorganic chemical compound with the formula Zn(NO₃)₂. It is a white crystalline solid. It is typically encountered as a hexahydrate Zn(NO₃)₂·6H₂O. Zinc Nitrate is soluble in both alcohol and water. The following Fig. 2 shows the structure of zinc nitrate.

<table>
<thead>
<tr>
<th>Properties of Zinc Nitrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular formula</td>
</tr>
<tr>
<td>Appearance</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td>Melting point</td>
</tr>
<tr>
<td>Boiling point</td>
</tr>
<tr>
<td>Flash point</td>
</tr>
</tbody>
</table>

B. Calotrophis Gigantea

Calotrophis gigantea is also known as Crown flower plant, Maddar, Rui. It is a large shrub growing to 4 m tall. It has clusters of waxy flowers that are either white or lavender in colour. Largely found in Cambodia, Indonesia, Malaysia, Philippines, Thailand, Sri Lanka, India, China and Pakistan. Fig. 3 show plant of calotrophis gigantea.
TABLE III
Scientific Classification of Calotrophis Gigantea

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order</td>
<td>Gentianales</td>
</tr>
<tr>
<td>Family</td>
<td>Apocynaceae</td>
</tr>
<tr>
<td>Subfamily</td>
<td>Asclepiadoideae</td>
</tr>
<tr>
<td>Genus</td>
<td>Calotropis</td>
</tr>
<tr>
<td>Species</td>
<td>C. gigantea</td>
</tr>
<tr>
<td>Binomial name</td>
<td>Calotrophis Gigantea</td>
</tr>
</tbody>
</table>

IV. MECHANISM

Zinc oxide nanoparticles are prepared by green synthesis method. For this method, take fresh leaves of Calotrophis Gigantea plants. The leaves were washed with water and then sun dried to remove the moisture. The extract of Calotrophis Gigantea leaves used as reducing agent. The preparation of leaves extract was prepared by placing washed and dried fine cut leaves and distilled water in (1:2) ratio in 250 ml glass beaker. The mixture of distilled water and fine cut dried leaves was then heated for 60 mins until the colour of the mixture solution changes. The leaves extract of Calotrophis Gigantea was cooled to room temperature and filtered using filter paper. The extract was stored in refrigerator for further experiments.

Take 50 ml of leaves extract and boiled upto 600-800 C by using a stirrer-heater. When temperature of solution reached at 600C then 5 grams of Zn(NO3)2 were as added to the solution. The mixture was then boiled upto reduce to a deep yellow coloured paste. This paste then collected in a ceramic crucible. This paste heated in an air heated furnace at 3000C for 120 min. A light yellow coloured powder was prepared and this was carefully collected. The powder was mashed in a mortar-pestle so as to get a finer nature for characterization. Fig.3 shows a flow diagram of ZnO nanoparticles preparation.

V. CHARACTERIZATION TECHNIQUES

1. X-Ray Diffraction (XRD) Analysis

X Ray Diffractometer utilized for analyse the structure and confirming the presence of ZnO.

2. Scanning Electron Microscope (SEM) Analysis

The SEM analysis is utilized for the structure of the reaction products that were formed.

VI. APPLICATIONS

ZnO nanoparticles has large number of applications in various fields because its interesting properties like wide bandgap, chemical stability, large binding energy. Following fig. 4 shows applications of ZnO nanoparticles in various industries.

![Fig. 4 Schematic representation all the application of ZnO NPs mentioned in the text](image-url)
International Journal of Emerging Technology and Advanced Engineering

VII. CONCLUSION

Zinc oxide nanoparticles are prepared by the green synthesis method. This method is best option to traditional method and also green synthesis method are less expensive, eco-friendly and ignore toxic chemical. ZnO nanoparticles used in different industries like rubber, electronic and electrotechnology industry, textile industry, pharmaceautical industry due to their amazing properties like antiseptic, anticrosive, antifungal.

REFERENCES