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Research Article

Green synthesis of ZnO nanoparticles by Calotropis Gigantea

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Abstract

Present study focuses on the green synthesis of ZnO nanoparticles by zinc nitrate and utilizing the bio components of leaves extract of Calotropis Gigantea. The ZnO nano crystallites of average size range of 30-35 nm have been synthesized by rapid, simple and ecofriendly method. Zinc nanoparticles were characterized using scanning electron microscopy (SEM) and X-ray diffraction (XRD). The particles obtained are spherical in nature and are agglomerates of nanocrystallite. The X ray patterns show hexagonal crystal type for ZnO. The results coincide with literature XRD pattern for hexagonal wurtzite ZnO. The size of nano crystallites is calculated by considering XRD data by Debye-Scherrer's Formula.

Keywords: *Zinc nanoparticles, Calotropis gigantea, Green-synthesis. X Ray Diffraction, Scanning Electron Microscopy*

1. Introduction

Nanotechnology is the technological innovations in the 21st century. Research and development in this field is growing rapidly throughout the world. A major contribution of this field is the development of new materials in the nanometer scale (J. Siva Kumar et al, 2001). These are usually particulate materials with at least one dimension of less than 100 nanomaters (nm), even the particles could be zero dimension in the case of quantum dots (Md Amin et al, 2012). Metal nanoparticles have been of great interest due to their distinctive features such as catalytic, optical, magnetic and electrical properties (Garima Singhal et al,2010). Nanoparticles exhibit completely new or improved properties with larger particles of the bulk materials and these novel properties are derived due to the variation in specific characteristics such as size, distribution and morphology of the particles(Ravindra P Singh et al, 2011). Nanoparticles present a higher surface area to volume ratio with decrease in the size, distribution and morphology of the particles (Akl M. Awwad1 et al, 2012).

The growing need of environmental friendly nanoparticles, researchers are using green methods for the synthesis of various metal nanoparticles for pharmaceutical applications(Akl M. Awwad1 et al, 2012). Often chemical synthesis methods like sol-gel process, micelle, chemical precipitation, hydrothermal method, pyrolysis, chemical vapour deposition etc. lead to the presence of some toxic chemical species adsorbed on the surface that may have adverse effects in medical applications. Some reactions require high temperature and/or high pressure for initiating the reaction, while some reactions require inert atmosphere protection, and/or using toxic matters such as H_2S, toxic template and stabilizer, and metallic precursors (Manish Hudlikar et al, 2012). Chemicals used for nanoparticles synthesis and stabilization are toxic and lead to non-ecofriendly byproducts (Garima Singhal et al, 2010). Biological approaches using microorganisms and plants or plant extracts for metal nano particles have been suggested as valuable alternatives to chemical methods. Several biological systems including bacteria, fungi and yeast have been used in synthesis of nanoparticles (G.Alagumuthu et al,2012). Synthesis of nanoparticles using microorganisms involves elaborate process of maintaining cell cultures, intracellular synthesis and multiple purification steps. In this regard Using "green" methods in the synthesis of zinc oxide nanoparticles has increasingly become a topic of interests as conventional chemical methods are expensive and re-quire the use of chemical compounds/organic solvents as reducing agents(Cynthia Mason et al, 2012).

The plant Calotropis gigantea belonging to the family Asclepiadanceae, also called as Alarka, Shwetarka, Mandara, Vasuka; is distributed through out India, dry wast land Sharma PC et al, 2008. Calotropis gigantea is a species of Calotropis native to Cambodia, Indonesia, Malaysia, Philippines, Thailand, Sri Lanka, India and China. (Sharma PC et al, 2008, Naheed Ahmad et al, 2012 , G.Alagumuthu et al, 2012). The different parts of the plant are used in Indian traditional medicine for the treatment of painful muscular spasm, dysentery, fever, rheumatism, asthma and as an expectorant and purgative.(Ravindra P Singh et al, 2011) To the best of our

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knowledge, biological approach using leaf extract of Calotrpis gigantea has been used for the first time as a reducing material as well as surface stabilizing agent for the synthesis of spherical-shaped ZnO-NPs. The structure, phase, and morphology of synthesized product were investigated by the standard characterization techniques.

2. Materials and Methods

Zinc nitrate (ZnNO3) and glassware was purchased from Vasa Chemicals, Malleswaram. All glassware was washed with sterile distilled water and dried in an oven before use. The procedure for the synthesis was referenced from literature (Gunalan Sangeethaa et al, 2011 , Manish Hudlikar et al, 2012).

a. Preparation of the leaf extract

Fresh leaves were collected from Calotropis Gigantea plants in the RVCE campus. The leaves were washed several times with water to remove the dust particles and then sun dried to remove the residual moisture. The extract used for the reduction of zinc ions (Zn2+) to zinc nanoparticles (Zn0) was prepared by placing 50g of washed dried fine cut leaves in 250 mL glass beaker along with 100 mL of sterile distilled water. The mixture was then boiled for 60 minutes until the colour of the aqueous solution changes from watery to light yellow. The extract was cooled to room temperature and filtered using filter paper. The extract was stored in a refrigerator in order to be used for further experiments.

b. Preparation of zinc nanoparticles

For the synthesis nanoparticle 50 ml of Calotropis gigantea leaves extract was taken and boiled to 60-80 degree Celsius using a stirrer-heater. 5 grams of Zinc Nitrate was added to the solution as the temperatures reached 60 degree Celsius. This mixture is then boiled until it reduced to a deep yellow coloured paste. This paste was then collected in a ceramic crucible and heated in an air heated furnace at 400 degree Celsius for 2 hours. A light yellow coloured powder was obtained and this was carefully collected and packed for characterization purposes. The material was mashed in a mortar-pestle so as to get a finer nature for characterization.

3 Result and Discussions

X-Ray Diffraction (XRD) Analysis

The powdered sample was used by a CuKa1- X Ray Diffractometer for confirming the presence of ZnO and analyse the structure. The graph showed main peaks corresponding to 2θ values of 31.74°, 34.41° and 36.23° in the multi-plot shown in Fig 3.1. The peaks of the graph are in good agreement with the literature report (JCPDS File no.5-0566). The location of the peaks was compared to literature values and the presence of zinc oxide particles was confirmed. The average size of the particles was calculated using Debye-Scherrer's formula:

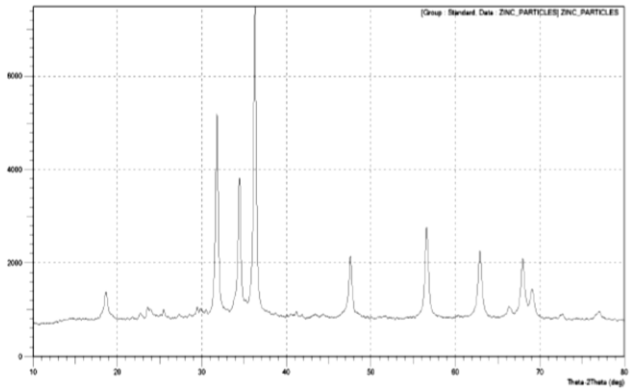

Fig 3.1 XRD pattern of zincoxide nanoparticles

Scanning Electron Microscope (SEM) Analysis

The SEM analysis was used to determine the structure of the reaction products that were formed. SEM image has showed individual zinc particles as well as a number of aggregates. The SEM image showed relatively spherical shape nanoparticle formed with diameter range 11-25 nm. Aggregated molecules where formed in the range of 10 µm shown in fig 3.2.

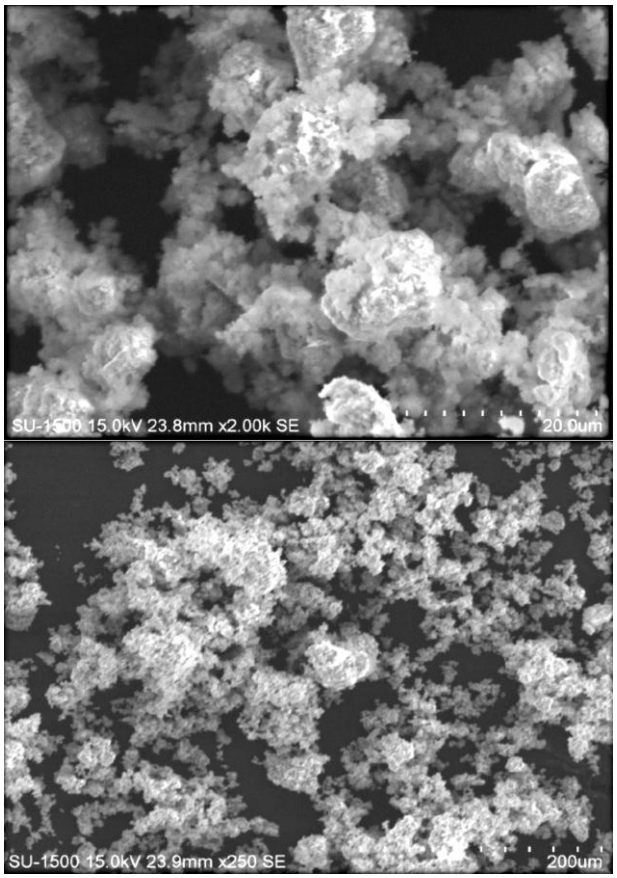

Fig 3.2: SEM images of zinc oxide nanoparticles

Conclusions

The rapid biological synthesis of zinc nanoparticles using leaf extract of *Calotropis gigantea* provides an environmental friendly, simple and efficient route for synthesis of nanoparticles. The use of plant extracts avoids the usage of harmful and toxic reducing and stabilizing agents. The synthesized nano crystallites of ZnO are in the range of 30-35 nm. Zinc nanoparticles can exist in ions only in the presence of strong oxidizing substances. The environmental conditions will affect the stability of nano particle and agglomerates are formed.

The synthesis of ZnO nano particles is still in its infancy and more research needs to be focused on the mechanism of nanoparticle formation which may lead to fine tuning of the process ultimately leading to the synthesis of nanoparticles with a strict control over the size and shape parameters.

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