VIVEKANAND COLLEGE, KOLHAPUR (Empowered Autonomous)

SEED MONEY SCHEME FOR RESEARCH

Annual/Final Report of the work done on the Research project

(Report to be submitted within 2 months after completion of each year)

1) Project report No. 1st/ 2nd (final): First report
2) University Reference No.
3) Period of report: From 01st November 2022 to 31st October 2023
4) Title of research project: **Green synthesis of CuO nanoparticles and their applications as catalyst**
5) (a) Name of the Principal Investigator: Dr. S. D. Shinde

   (b) Department and College where work has progressed: **Department of Chemistry, Vivekanand College, Kolhapur (Empowered Autonomous)**
6) Effective date of starting of the project: **01st November 2022**
7) Grant approved and expenditure incurred during the period of the report:

   a. Total amount approved Rs. 130,000/-

   b. Total expenditure Rs. 12,153/-

   c. Report of the work done:

1) Brief objective of the project:

   (a) Main objectives of this work is to obtain CuO nanoparticles as green catalyst due to their recycling and reuse with ubiquitous properties such as greater surface area, high thermostability and ease of recovery.

   (b) This synthesis shows a green chemistry approach as it is free from toxic and harmful solvent.

   (c) Synthesis of Nanomaterials by using the Multicomponent Reactions which is a powerful advanced synthetic method.

   (d) These CuO nanoparticles can be applicable as antibacterial, antifungal and antimicrobial agents in pharmaceutical and medicinal industry.

   (e) CuO nanoparticles are used in supercapacitor, solar cell, photo degradation of dyes and smart Windows industries.

   (f) Synthesis of nitrogen containing highly complex heterocyles which possess number of biological activities as antiinflamatory, analegesic, antineoplastic, antidiabetic and antitubercular.

2) Work done so far and results achieved and publications, if any, resulting from the

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work (Give details of papers and names of the journals in which it has been published or accepted for publicaion)

- Comunicated one research paper in internationally reputed journals.

3) Has the progress been according to original plan of work and towards achieving the objective. if not, state reasons.

- Yes, the progress has been according to original plan of work towards achieving the objective of the project.

4) Please indicate the difficulties, if any experienced in implementing the project.

- Nil

5) If project has not been completed, please indicate the approximate time by which it is likely to be completed. A summary of the work done for the period (Annual basis) may please be sent to the university on a separate sheet.

- Half of the project has been successfully completed, and one research papers have been submitted to research journal. The project will be completed within the stipulated time frame. (Attached a separate sheet for summary of the work done)

6) If the project has been completed, please enclose a summary of the findings of the study. Two bound copies of the final report of work done may also be sent to the Univeristy.

- Nil

7) Any other information which would help in evaluaion of work done on the project. At the completion of the project, the first report should indicate the output, such as (a) Manpowe trained (b) Ph.D. Awarded (c) Publication of results (d) other impact, if any.

- Research paper communicated in the internationally reputed journals.

Summary of the project work done

(Period of report: From 01st **November** 2022 to 31st **October** 2023)

Green synthesis of CuO nanoparticles and their characterizations:

In the first stage, we have done extensive literature review pertaining to the green synthesis of CuO oxide nanomaterial using biological resources. Although significant works had been reported using various plant-based extracts to formulate

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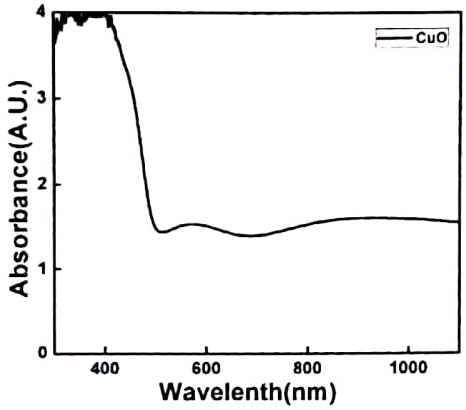
several metal oxide nanoparticles, the use of Thevetia Peruviona plant extract mediated biosynthesis of CuO nanoparticles explicitly is not seen in literature. So our work reports the green synthesis CuO NPs by using Thevetia Peruviona as green reducing and capping agent for the first time to our knowledge.

The synthesized supported metal oxide nanomaterial is confirmed by using UV–Visible spectroscopy, XRD, SEM, FTIR analysis.

Optical Absorption Study:

The room temperature optical absorption spectra of the CuO NPs solution in the range of 380-1000 nm without taking into account scattering and reflection losses. Fig. 1 shows variation in the optical absorption with wavelength.



The extrapolation of straight line portions to zero absorption coefficient (α = 0), leads to the estimation of the band gap energy values which is found to be 2.1 eV due to quantum size effect. Quantum confinement leads to a collapse of the continuous energy bands of a bulk material into discrete, atomic like energy levels. Thus, one observes an increase in the band gap of the semiconductor with a decrease in the particle size.

X-Ray Diffraction (XRD) Study:

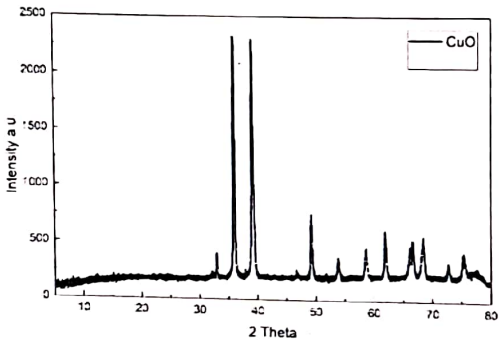
The XRD patterns of the CuO thin films are shown in Fig. 2. The comparison of observed XRD patterns with the standard JCPDS data (Card no. 80-0076) confirms the formation of a CuO phase with monoclinic crystal structure.

The lattice parameters were calculated from XRD data is as follows, a = 4.529 Å, b = 3.43 Å, c = 5.07 Å . The CuO film exhibits XRD peak corresponding to (110) plane. Besides this major peak, nine more peaks corresponding to (111), (220), (202), (020), (113), (022), (420), (422) and (311) planes are observed. This suggests that, CuO phase is stable.

Further, the average crystallite size was calculated using a well known Debye-Scherrer's formula:

$$D = \frac{0.9\lambda}{\beta \cos\theta}$$

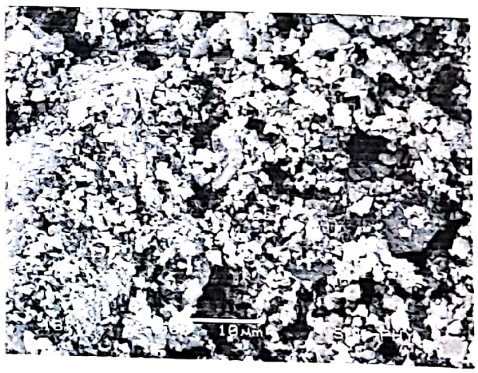
where, λ is the wavelength of X-rays (1.5406 Å), β the full width at half maximum (in radian) of the peak, D is the diameter of the crystallite and θ is Bragg's angle of XRD peak. Further, the average crystallite size is estimated using Scherrer's formula is approximately 20.41nm.



X-ray diffraction pattern of the CuO NPs.

Scanning Electron Microscopy (SEM) Study:

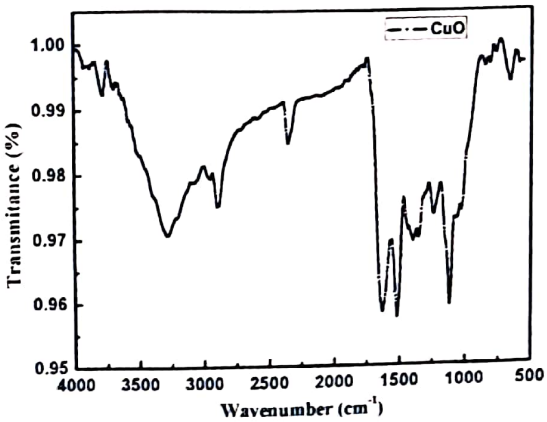
SEM study shows in Fig.3 that CuO NPs having bulky nature with some smaller agglomeration. Average grain size was 50 nm.



SEM images of the CuO NPs.

Fourier Transform Infrared (FT-IR) Spectroscopy:

FT-IR spectroscopy was carried out to identify the functional groups present in the C. ternatea which acts as reducing and capping agents of synthesized CuO NPs as shown in Fig. 4.



FTIR transmission spectra of the CuO thin film was recorded in the wave number range of 550-4000 cm-^{1}.

The interaction of plant compounds with the chemical has shifted from weak to strong and broad peak at 3288 cm^{-1} due to water molecule, 2896-2977 cm^{-1} due to the alkyl group, 2350 cm^{-1} is the band arising from the absorption of atmospheric CO2 on the metallic cations, 1624 cm^{-1} assigned to C=C aromatic stretch, 1533 cm^{-1} is the stretching mode of vibration corresponding to C=C, 1394 cm^{-1} assigned to C–H alkenes stretch, 1121 cm^{-1} assigned to C–N amines stretch, 758 cm^{-1} and 667cm^{-1} assigned to C–H alkenes stretch and the peak observed at 577 cm^{-1} indicates the presence of CuO NPs.

Other characterizations TEM, FE-SEM and efficiency of CuO nanoparticles as catalyst for the various organic reactions are under process. We also carried out antimicrobial test of the biosynthesized copper nanoparticles.

Throughout our research tenure, we are presented our research work at national conference through presentations.

Signature of the Principal Investigator: Shinde (Dr. S.P. Shinde)

Signature of the Principal:

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