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Synthesis of Copper Oxide Nanoparticles by Miscanthus Sinensis (Silver Grass) Leaf Extract

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ABSTRACT

In materials physics, "green" synthesis has gained attention as a sustainable, reliable and eco-friendly protocol for synthesizing a wide range of nanomaterials including metal/metal oxides nanomaterials, bioinspired, and hybridmaterials. In the past numerous years, the utilization of synthetic concoctions and physical strategies were in mould; however, the acknowledgment of their toxic impacts on human well-being and condition influenced serious worldview for the researcher. Since, green synthesis is the best option to option to opt for the synthesis of nanoparticle, therefore the nanoparticles were synthesized by using aqueous extract of Miscanthus Sinensis (Silver grass) and metal ions (such as Copper Oxide). Copper was of particular interest due to its distinctive physical and chemical properties. Miscanthus Sinensis leaf extract was selected as it is of high medicinal value and it does not require any sample preparation and hence is cost- effective. The fixed ratio of plant extract and copper ions were mixed and kept at room temperature for reduction. The colour change from Green to black confirmed the formation of nanoparticles. Further, the synthesized nanoparticles were characterized by standard Physio-chemical techniques like DLS, UV-VIS, AAS and zeta potential.

Keywords- Green synthesis, nanomaterials, Silver grass, Copper oxide**.**

I. INTRODUCTION

The concept of nanotechnology was first begun with lecture delivered by Richard Feynman in 1959[1,6,17]. Nanotechnology is an enabling technology that deals with nano rang materials in different field of science such as physics, chemistry, biotechnology, and material science[7,19]. In nanotechnology nanoparticles research is an important aspect due to its innumerable applications. Nanoparticles have expressed significant advances owing to wide range of applications in the field of bio-medical, sensors, antimicrobials, catalysts, electronics, optical fibers, agricultural, bio-labelling and in other area (figure 1)[1,18].

The various processes available for the synthesis of nanoparticles like lithographic techniques, ball milling, etching and sputtering[3,19]. The use of a bottom up approach also includes may methods like chemical vapor deposition, sol-gel processes etc (figure2)[5,7]. Nevertheless, if these synthesized nanomaterials are subject to the actual/specific applications, then they can suffer from the following limitation or challenges: (i) stability in hostile environment, (ii) lack of understanding in fundamental mechanism and modeling factors, (iii) expansive analysis requirements, (iv) need for skilled operators, (v) problem in devices assembling and structures, and (vi) recycle/reuse/regeneration[1-5]. On the other hand, these limitations are opening new and great opportunities in this emerging Feld of research[3].

Figure 1: Show the overview applications of nanoparticle.

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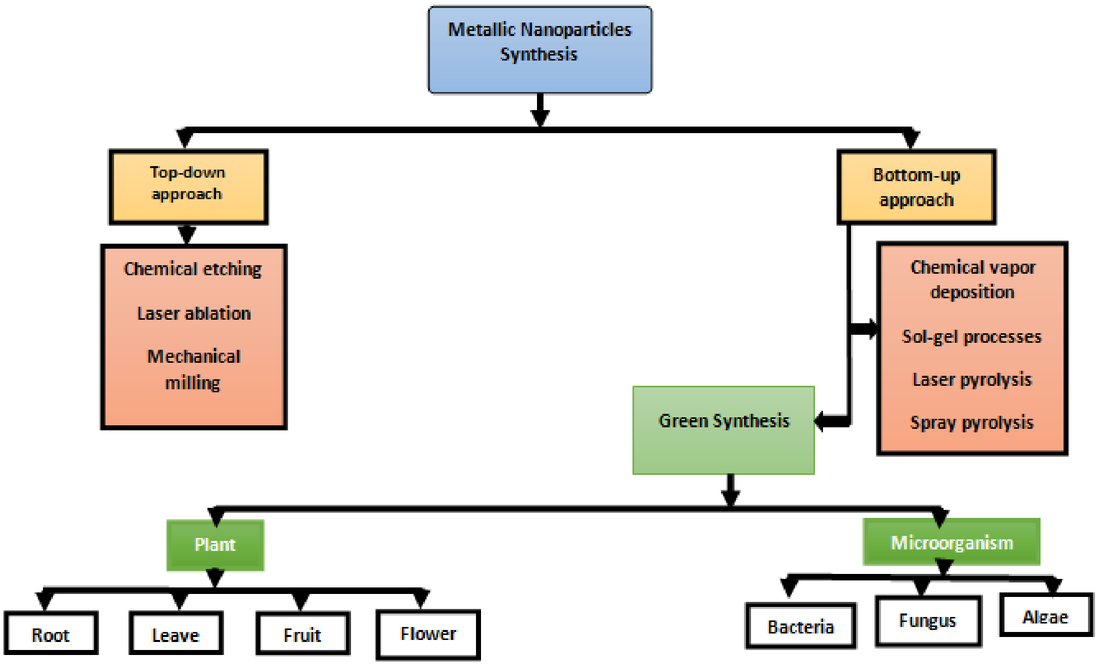

Figure 2: Show the different synthesis approaches available for the preparation of metal nanoparticles.

To counter those limitations, a new era of 'green synthesis' approaches/methods is gaining great attention in current research and development on materials science and technology[3]. Green synthesis of nanoparticles (NPs) using plant extracts is an emerging area of research and is potentially advantageous over chemical or microbial synthesis as it eliminates the elaborate process and can also meet large-scale production[2,3,8]. Metalnanoparticles have received significant attention in recent years owing to their unique properties and practical applications. Copper oxide (CuO) is a p-type semiconductor material with a narrow band gap of 1.2 eV. In recent years, they are receiving lot of attention for their versatile properties and potential use as gas sensors, solar cells, lithium-ion batteries, heterogeneous catalysts and antibacterial agents. Besides, CuO nanoparticles are stable, robust and have a longer shelf life compared to organic, antimicrobial agents.[9-12]

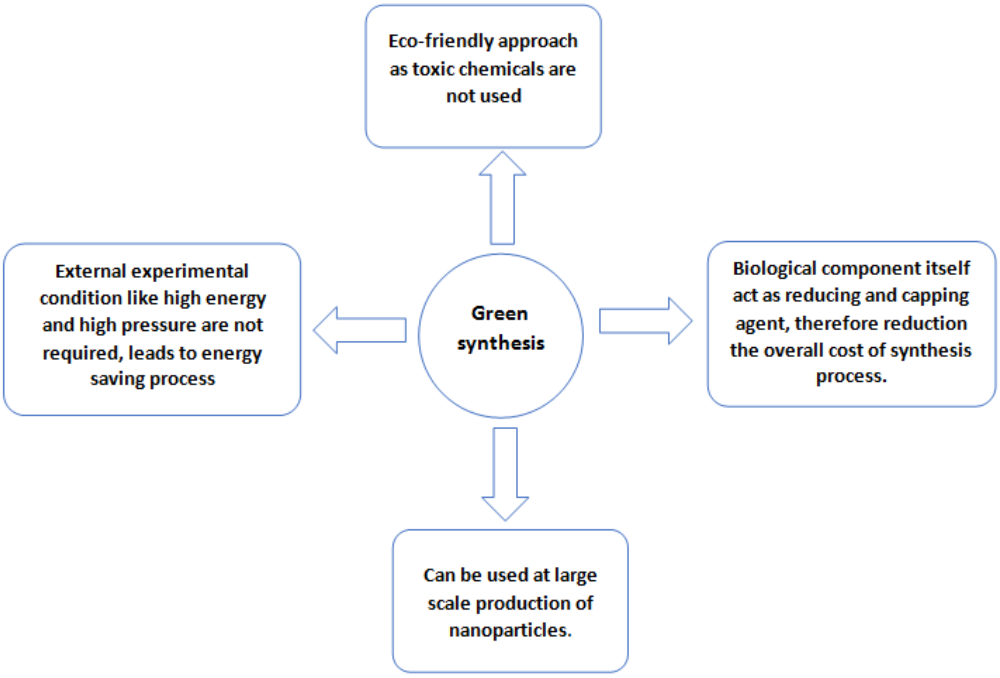

Figure 3: Show the key merits of green synthesis method.

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From review literature, there are very few reports on plantmediated synthesis of metal oxide nanoparticles[13-15]. During the present study, Silver grass plant is used for the green synthesis of Cu Onanoparticle. Plant mediated synthesis of copper oxide (CuO) nanoparticles has popularized because of their simplicity, Eco-friendliness and extensive antibacterial properties.

II. EXPERIMENTAL

Material

This research work was carried out in the Advance science & Technology research centre, Vinoba Bhave University Hazaribagh (Jharkhand). All chemicals used were of analytical grade; and were purchased from Sigma-Aldrich. Miscanthus sinensis (Silver grass) leaves were collected from botanical garden of department of Botany, Vinoba Bhave University, Hazaribagh, Jharkhand, India

Preparation of grass extract

Grass leaf extract of Miscanthus Sinensis was prepared by taking 10g of the fresh leaves were chopped and properly washed using the normal water and then with distilled water. In order to sterilize the leaves they were washed using 70% ethanol for about 50 sec time was maintained live ethanol may can dehydrate the leaves. After washing leaves were left for surface drying. The finely chopped material was allowed to boil for 15 min at 100 °C with 100 mL of distilled water in a 250-mL Erlenmeyer flask and then cooled down to room temperature. The resulting solution is passed through muslin cloth to separate the extract.

Synthesis of Copper oxide nanoparticle

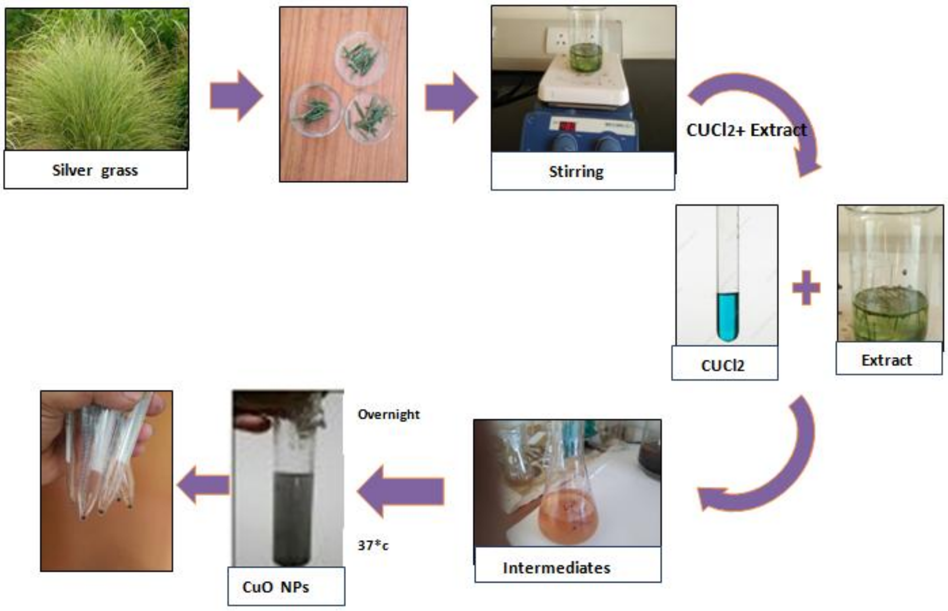

Figure 4: Schematic showing the Synthesis of Copper Oxide nanoparticles.

CuO NPs were synthesis using the green combustion method, with the leaf extract of Silver grass and $CuCl_2$ was mixed with 1:3 ration. Colour change of the reaction mixture was observed from deep blue to colourless and then to dark red on viperous stirring for 24 h. Then the resultant solution is centrifuged at 2,000 rpm for 30 min, at room temperature, which resulted in two different constituents, were found namely pellet and supernatant. In which pellet was collected and given was for 3-4 time. Another nanoparticle were formed at different concentration such as 2mM, 5mM, 10mM, and 20mM. This was done in order to compare the nanoparticles with respect to their size and stability. All date generated or analysed during this study are includes in this work.

III. CHARACTERIZATION OF COPPER OXIDE NANOPARTICLE

The characterization of biogenically synthesized CuO NPs has been carried out by using analytical tools namely, UV-visible spectro photometer (Agilent Technologies, model no= MC187906), Dynamic light scattering (DLS) and Atomic absorption spectrophotometer (AAS). The UV-Visible spectroscopy was applied to detect colour change in CuO NPs synthesised by using Silver grass, which is possibility due to the surface plasmon vibration. Dynamic light scattering analysis of incident photons is used to determine the surface charge and the hydrodynamic radius of the Nanoparticles.

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IV. RESULTS AND DISCUSS

Formation of Copper oxide (CuO) nanoparticle

Green synthesis of copper oxide NPs was carried out with the help of silver grass extract as show in fig.4, Dark greenish colour with black precipitate was observed and then mixed small amount $CuCl_2$ to get black suspension with black precipitate indicated the synthesis of Copper oxide (CuO) nanoparticle.

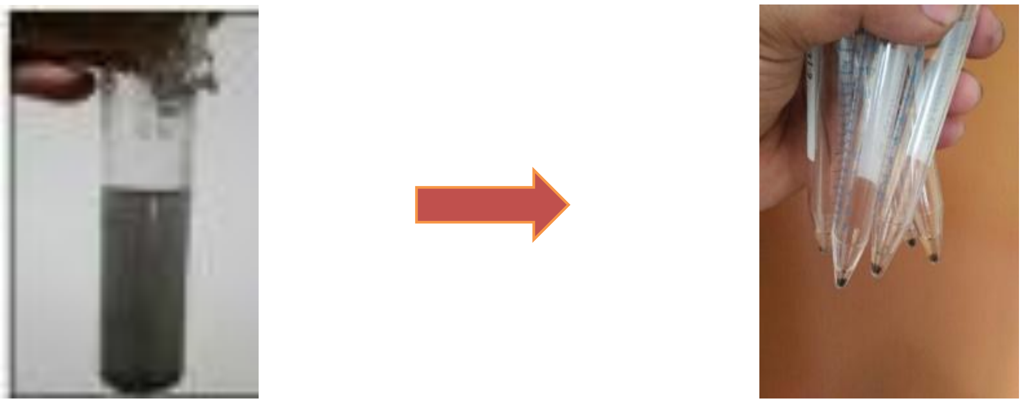


Figure 5: (a) Show the Copper oxide nanoparticle solution (b) show the after centrifuged CuO.

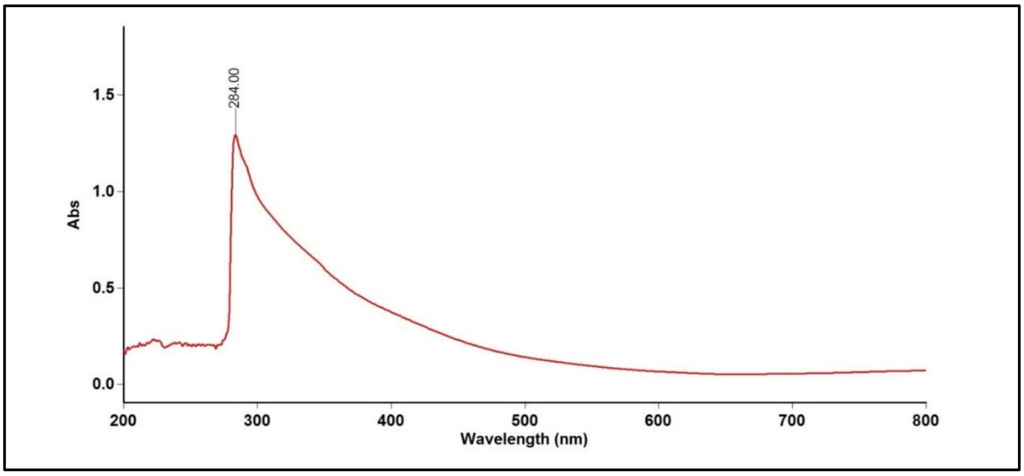
Optical properties of Copper Oxide nanoparticle

UV–Vis spectroscopy is an important technique to establish the formation and stability of metal nanoparticles in aqueous solution. The relationship between UV-visible radiation absorbance characteristics and the absorbate's size and shape is well known. Consequently, shape and size of nanoparticles in aqueous suspension can be assessed by UV-visible absorbance studies.

Absorbance is a measure of the quantity of light absorbed by a sample. It is also known as optical density or decadic absorbance. The Beer-Lambert law is used to calculate absorbance;

A= ebc

Where **A** is absorbance (**A= log10P0/P**)
e is the molar absorptivity with units of **L** $\mathbf{mol^{-1}cm^{-1}}$
b is the path length of the sample, usually the length of a cuvette in centimetres.



C is the concentration of a solute in solution, expressed in **mol/L**

Figure 7: UV-Vis absorption spectrum of CuO NPs synthesized by treating 1mM Copper (II) chloride solution with Silver grass leaf extract after 2 hrs.

Fig. 7 depicts the absorbance spectra of reaction mixture containing aqueous Copper(II) chloride solution (1 mM) and Silver grass leaf broth (prepared from 10 g leaf material). The absorption spectra obtained reveal the production of CuO NPs within 2 h. On adding the afore-mentioned plant broth to $CuCl_2$ solution, the solution changed from Dark greenish to Black. The final colour turns deep and finally, black with passage of time. The intensity of the absorbance was found to increase as the reaction proceeded further. As indicated by fig.7, SPR peak at 285 nm was observed with four more peak around 283-286 nm at different concentration 2mM, 5mM, 10mM and 20mM.

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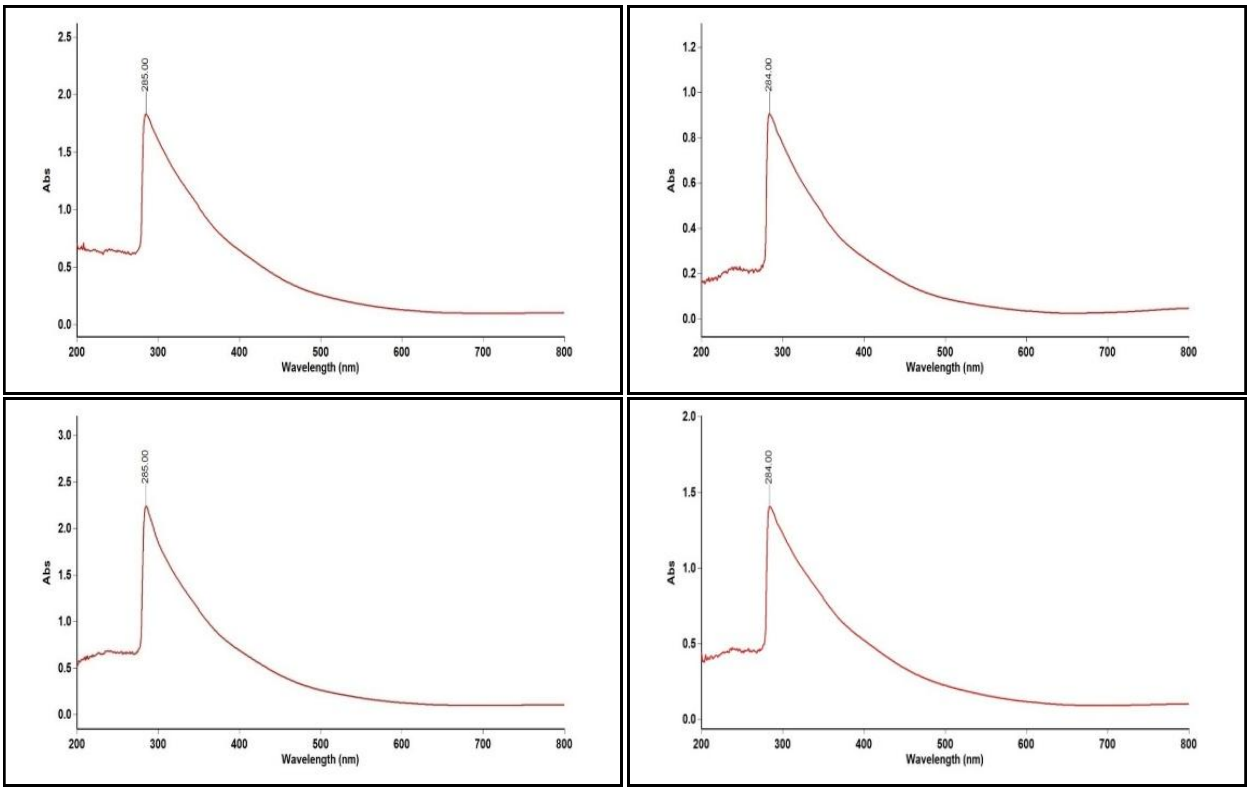

Figure 8: UV-Vis absorption spectrum of CuO NPs synthesized by treating different concentration (2mM, 5mM, 10mM and 20mM) of Copper (II) chloride solution with Silver grass leaf extract after 2 hrs.

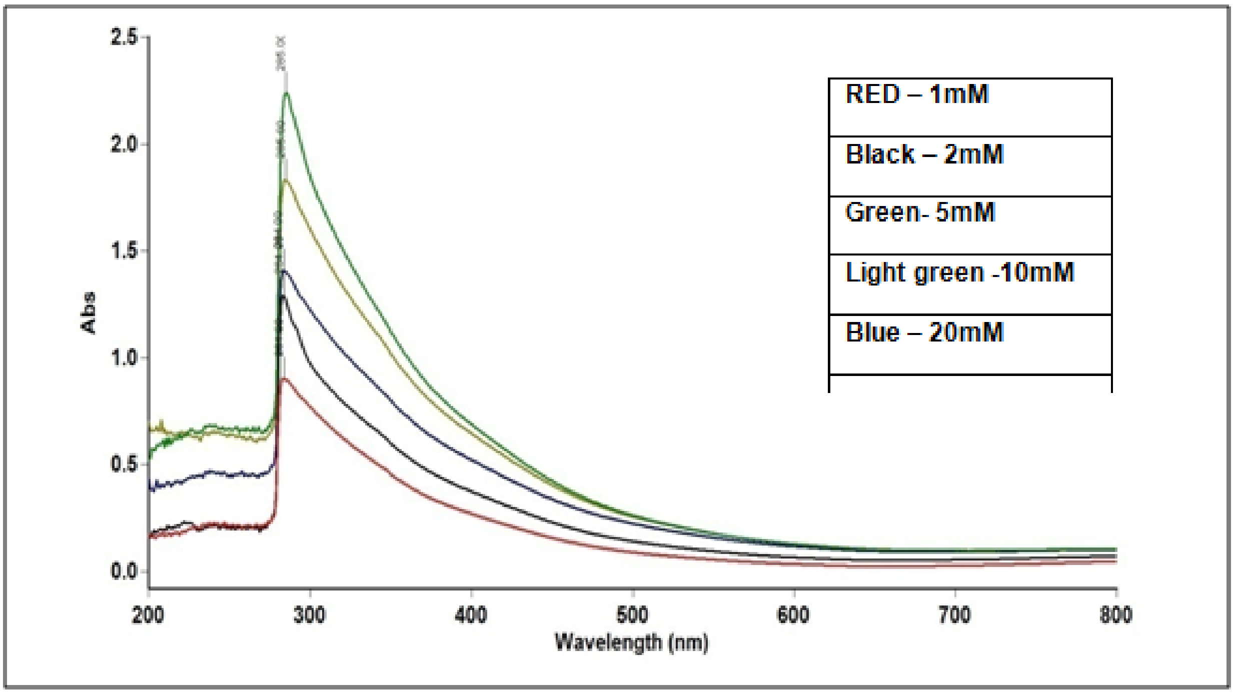

Figure 9: UV-vis spectrum of green synthesized Copper Oxide (CuO) NPs.

Zeta potential and size distribution measurements by dynamic light scattering (DLS)

Zeta potential is an important parameter related to the stability of nanoparticles. Zeta potential is a potential difference between the two suspended particles present in colloidal suspension.

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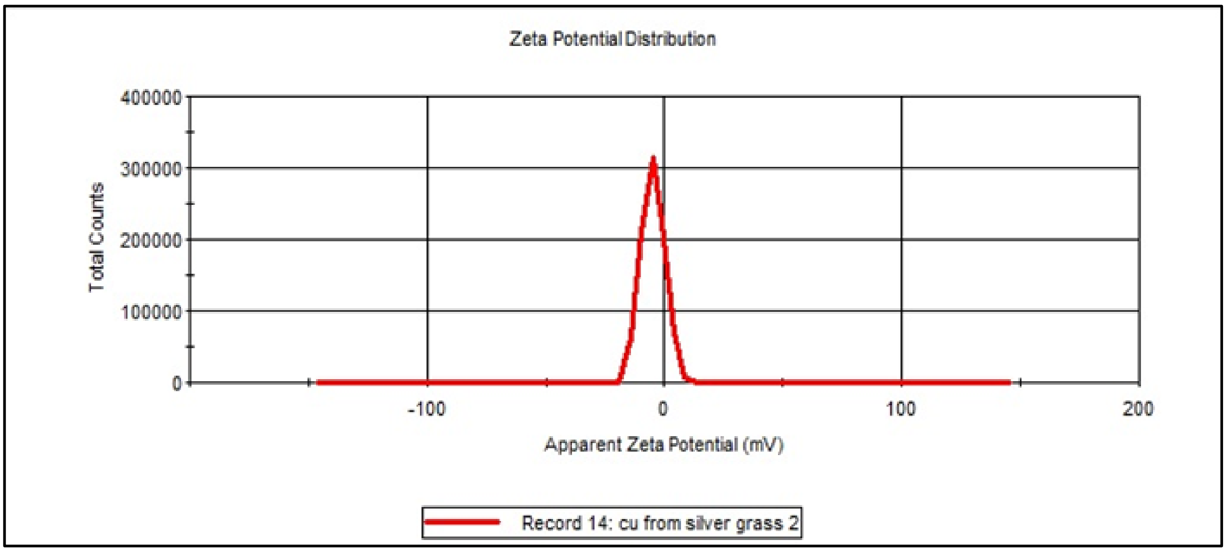

Figure 10: Zeta potential value and zeta potential distribution graph of CuO NPs.

It is a physical property which confirms the stability of nanoparticles. Higher negatives zeta potential denoted the strong repulsion force between the particle indicating stability and quality. The stability of CuO NPs was evaluated by determination of zeta potential in the freshly prepared solution and after 48 h. As shown in fig 10, the zeta potential of nanoparticles was found to be 07±02Mv which remain significantly unchanged 05±02Mv .after 48h.

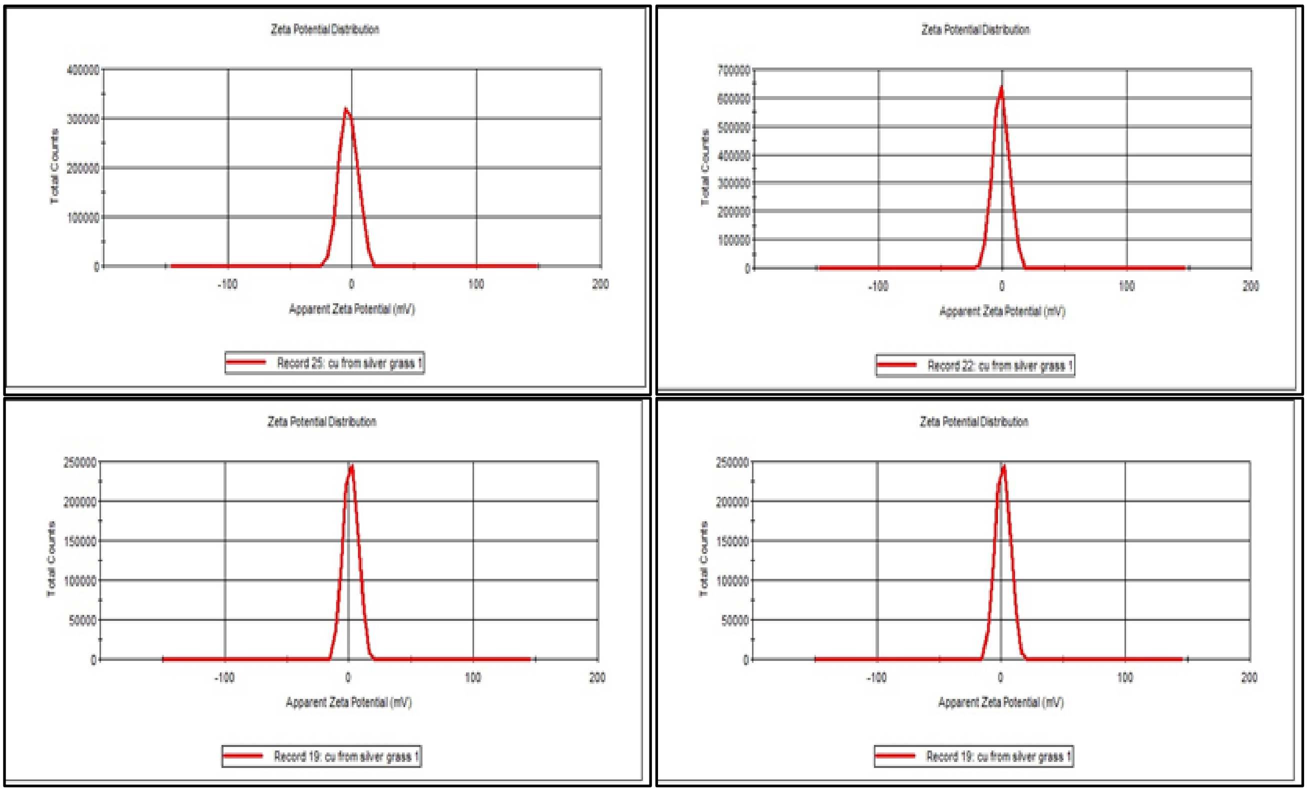

Figure 11: Zeta potential value and zeta potential distribution graph of different concentration of CuO NPs.

Dynamic light scattering is one of the most commonly used techniques to determine the size of nanoparticles. The dynamic light scattering (DLS) analysis results for size distribution were also in support of the FE-SEM results. The results were displayed as an intensity-based Particle Size Distribution a as shown in Figures 12.

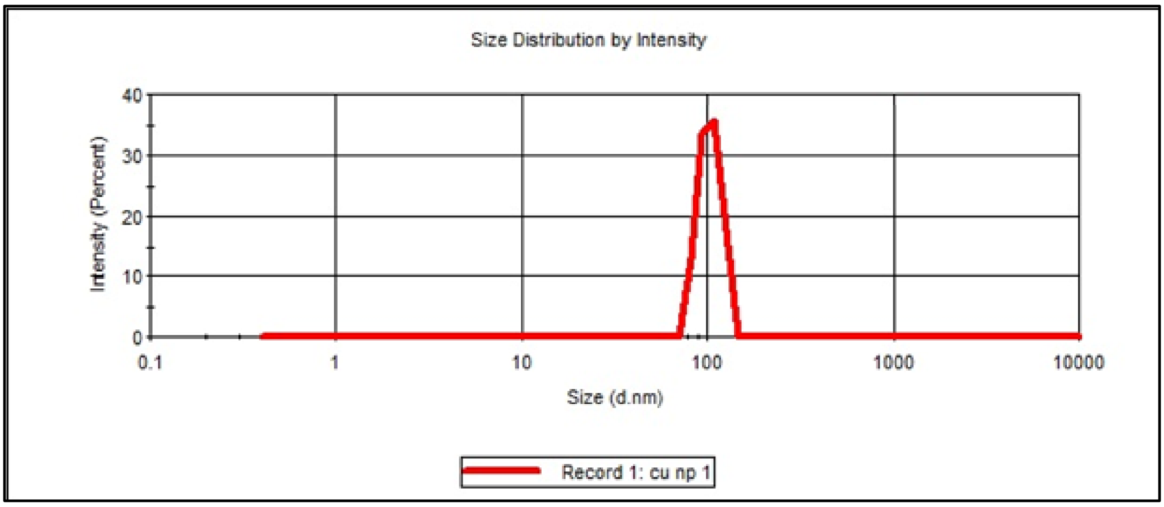

Figure 12: Particle size distribution (PSD) of synthesized Copper Oxide Nanoparticles.

Application of Copper oxide nanoparticles

Metal nanoparticles have received significant attention in recent years owing to their unique properties and particle applications. In the last few years, copper and copper oxide nanoparticles were involved in many applications; this encouraged many researchers worldwide to develop more facile synthesis methods. Unprecedentedly, the current study reports a green method for synthesizing copper/copper oxide nanoparticles (Cu/Cu2O NPs) using the extract of silver grass. Copper oxide (CuO) has a wide range of applications in various fields, from energy conversion and storage through environmental science, electronics and sensor[1]. CuO nanoparticles have received a lot of attention because they are the simplest members of the family of copper salts, and they possess a range of useful physical properties such as electron correlation effects, spin dynamics and high temperature superconductivity[2]. The unique properties of CuO nanoparticles and their potential applications have continued to attract a lot of attention[3]. CuO nanoparticles are used to improve viscosity of energy transferring fluids, thereby boosting thermal conductivity[4]. In industrial fields, CuO nanoparticles are widely used as p-type semiconductors and transistors in the design and production of batteries[4], solar cells[5], gas sensors[6] and field emitters[7][16].

V. CONCLUSION

The air of this paper is focused on the synthesis and characterization studies of Copper oxide nanoparticles. This work clearly demonstrates the application in green chemistry of a method for synthesizing Copper oxide nanoparticles with desirable characteristics using the leaf extract (Silver grass). Synthesized Copper oxide nanoparticles were well capped and stable. The increased applicability of copper and copper oxide nanoparticles among different fields, including but not limited to medical, industrial, biological and electronic. On the other hand, green methods are still attracting more attention and interest due to its simplicity, cost efficiency, nontoxicity and being environment-friendly. The green synthesized Copper oxide nanoparticles were characterized using various analytical techniques UV–Vis spectroscopy, and DLS studies.

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