Green Synthesis And Characterization of Copper Oxide Nanoparticles Using Solanum Nigrum Leaf Extract

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Abstract- *Green Synthesis of metal nanoparticles was pacified in its beginning. Owing to the enlarging call far diverse nanoparticles, it is inevitable to evolve the synthesis manners that are advantageous and ambiance friendly. To be ascribed to the eminent cost and the quality of physical and chemical approaches, the necessity for green synthesis of nanoparticles is moderately enlarging. On the account of examine of low-priced choices, examiners have originate to utilize the biological elements and molecules that act as reducing agents, containing micro-organisms, bio- molecules, extracts from plants, moderately enlarging. Copper Oxide nanoparticles was synthesized by using solanum nigrum leaf extract and characterized by following methods. UV-Vis absorption, XRD, EDX, FTIR and SEM analyses were used to characterize the synthesized Copper Oxide nanoparticles.*

Keywords: Green Synthesis, solanum nigrum.

I. INTRODUCTION

In the present years the nanotechnology is become the most influential and unavoidable forefront fields of Physics, Chemistry, Engineering and Biology. It shows that great assurance for providing us in the near future with many break through that will change the direction of technological advances in a wide range of close attentions. To call over the absolutely broad benefits of this new technology is an important to have an available overall concise and narrative on the subject which is adequate detailed to contribute a expanded coverage and insight into the research area, and at the same time it is sufficiently readable and thorough so that it can reach a wide people of those who have a need to know the nature and prospects for the field. The common widespread interest in nanotechnology note the time of back to the years of nineteenth century undertook a world-wide contemplate of research and development in the domain of nanotechnology, with determine upon of fix its potential for technological change.

The dependence of the behavior on the particle sizes can authorize one to governing their properties. The prefix nano in the word nanotechnology means a billionth ($1x10^{-9}$m). Nanotechnology extents with diverse structures of matter having dimensions of the order of a billionth of a meter.

II. SOLANUM NIGRUM

Solanum nigrum, naturally known as Black Night Shade. It was also termed as “Manathakkali” in Tamilnadu, India. *Solanum nigrum*, was a assemblage of flowering plant in the universal *Solanum*. Its original inhabitant was Asia and dispersed over many countries in the world[11,12,13]. Matured fruits and leaves of *Solanum nigrum* plants were used as nutriment in various places, and plant portions were used as a traditional medicine[25]. *Solanum nigrum* plant was one of the comprehensible medicinal plants in India[12,23,25,34]. The whole *Solanum nigrum* plant was shown in Fig.1.

Fig.1.: Whole plant of *Solanum nigrum*

SCIENTIFIC CLASSIFICATION OF BLACK NIGHT SHADE

Kingdom	:	Plantae
Order	:	Solanales
Family	:	Solanaceae
Genus	:	*Solanum*

Species : *nigrum*
Botanical title : *Solanum Nigrum*
Habitual name : Back night shade

Black Night Shade was a stale plant laid foundation in manifold forest-crowned domain, as well as dispensed natural localities. Its leaves were 4.0cm to 7.5cm drawn out and 2cm to 5cm wide and heart-shaped, with sharp edges and exteriors were hairless[18,19,20]. The flowers have petals greenish to whitish, crooked when aged and fence about conspicuous lustrous yellow Anthers.

MEDICINAL APPLICATIONS

Solanum Nigrum was an important ingredient in traditional Indian medicines. *Solanum Nigrum* plant constituted of colossal aggregate of Inorganic Compounds analogous Copper, Silver, Sodium, Zinc, Cadmium, Ferrous, Magnesium, Potassium are attentive in the *Solanum nigrum* plant. Infusions are used in stomach complaints, and fever. The juice of the plant was used on ulcers and other skin diseases. The fruits are used as a tonic, laxative, appetite stimulant, and for treating asthma and excessive thirst. This plant's leaves were used to treat mouth ulcers that happen during winter periods of Tamil Nadu, India.

III. SYNTHESIS OF COPPER OXIDE NANOPARTICLES

The Copper Oxide nanoparticles was synthesized by Sol-Gel method. 0.1M solution of homogenous Copper Sulphate solution and the reflexed *Solanum Nigrum* leaves extract were taken for the green synthesis of Copper Oxide nanoparticles.

IV. PREPARATION OF COPPER SULPHATE SOLUTION

To synthesis the Copper Oxide nanoparticles, 0.1M solution of Copper Sulphate was prepared. By taking 2.42g of Copper Sulphate powder stirred with 100ml of distilled water. The stirring process was stretched out for 30min at the rate of 600rpm. In the rear of 30min Copper Sulphate powder was perfectly dissolved with the distilled water. The Copper Sulphate solution was blue in color. The obtained homogenous Copper Sulphate solution was bringing over for the further process.

Fig.2.: 0.1M homogenous Copper Sulphate Solution

V. SYNTHESIS OF COPPER OXIDE NANOPARTICLES

100ml of *Solanum Nigrum* leaf extract was stirred with 100ml of Copper Sulphate solution. This mixture was stirred for 60min at the rate of 600rpm. At this moment the solution was changed into dark green in color. Later stirring for one hour, the solution was maintained under rest for the particles to get precipitate. The Solanum Nigrum leaf extract precipitate was shown in Fig.3. The precipitate was gathered and centrifuged for 30min with 200rpm. The Centrifuged particles were collected and shade dried. Green synthesized Copper Oxide nanoparticles was shown in Fig.4.

Fig.3: *Solanum Nigrum* Leaf Extract Sediment

Fig.4.: Synthesized Copper Oxide nanoparticles

VI. RESULTS AND DISCUSSION

The formation of Copper Oxide nanoparticles was initially confirmed visually. Various Diffraction and Spectroscopic techniques which has been used to analyze the green synthesized Copper Oxide nanoparticles using *Solanum Nigrum* leaf Extract.

VII. UV- VIS ABSORPTION SPECTRUM ANALYSIS:

The UV- Vis Absorption spectrum was the initiatory and beneficial technique for investigating the metal nanoparticles as the peak position and the shape is perceptive to the size of synthesized nanoparticles[23]. The change in color from dark brown to dark green was due to the Surface Plasmon Resonance. The Surface Plasmon Resonance was actually perceptive to the particle size and shape.

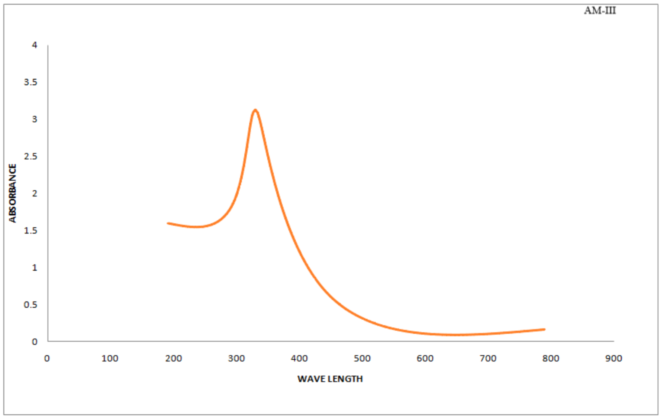

Fig.5: UV-Vis Spectrum of synthesized Copper Oxide nanoparticles

The UV- Vis absorption spectrum of Copper Oxide nanoparticles was shown in Fig.5. The absorption test ranges between 200nm to 900nm. The UV- Vis absorption spectrum consists of only one distinctive sharp and identical absorption peak. The absorption starts from approximately 280nm and reaches the maximum at 350nm and decreases gradually. The maximum absorption of 350nm infers that the material absorbs the maximum Ultra Violet emission of light and its atoms get excited. This was well agreement with S Rajeshkumar et al observed that the Copper Oxide nanoparticles using *Persea Americana* seeds exhibits maximum absorption peak at 357nm[21]. The absorption band of the Copper Oxide nanoparticles exhibits a blue shift occasioned by quantum restraint of the excitons exhibit in the sample.

Band Gap Energy (E_G):

The band gap (E_G) is the gap in the energy between the bound state and the free state, between the Valence Band and Conduction Band. Therefore, the band gap is the minimum change in energy required to excite the electron so that it can participate in Conduction[25]. Band Gap Energy was calculated by the following expression[25],

$$E_G = 1240/\lambda \text{ eV}$$

The Optical Band Gap (E_G) of synthesized Copper Oxide nanoparticles was calculated to be, **3.54eV**, for the **λ** value to be, 350nm.

VIII. X-RAY DIFFRACTION ANALYSIS

The X-Ray diffraction of the synthesized Copper Oxide nanoparticles was given in the Fig.6. The diffraction pattern exhibits the Crystalline nature of CuO[16]. The diffraction peaks were observed from 2θ values of 20º to 69º.

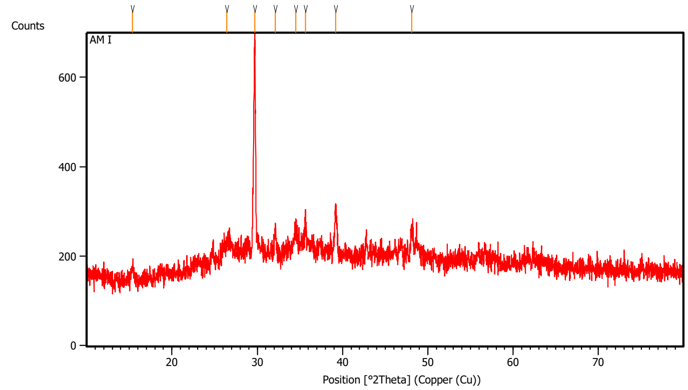

Fig.6: X-Ray Diffraction of synthesized Copper Oxide nanoparticles

The 2θ values are compared with the Standard Diffraction data taken from the **JCPDS Card No: 01-080-1916**. The peak values of the JCPDS data of Copper Oxide nanoparticles was given below. These values are 23.58º (100), 26.15º (101) 29.57º(102)32.70º(110) 35.19º(201) 39.64º(202) , 48.51º(210) and 56.24º(300). The peaks of observed for the *Solanum Nigrum* sample of Copper Oxide nanoparticles was 26.42º(101) 29.72º(102) 32.10º(110), 34.53º(200), 35.67º(201), 39.18º(202) and 48.13º(210). The sharp peak denotes that the highly crystalline nature of the synthesized Copper Oxide nanoparticles. The maximum observable diffraction peak was **29.72º**. The spectrum was identical to that of pure Copper Oxide that was indicating the formation of single-phase Copper Oxide with monoclinic structure. The supplementary peaks may be due to the organic substances at hand in the prepared sample. The average particle size of the Copper Oxide nanoparticles was calculated to be **32.37nm**.

The Particle size was calculated using the Debye's Schrerrer's Formula.

Dislocation Density:

Dislocation Density was a standard of the computation of the dislocations in a unit volume of a crystalline material. There are two significance of Dislocation Density. First, intense dislocation density was united with greater strength for steady-state deformation. Second, the dislocation density was linked with constant strain and stress rate. The dislocation density (δ) of the synthesized Copper Oxide nanoparticles was determined by the expression [21].

$$\delta = 1/D^2 \text{ m}^2$$

The mean Dislocation Density (**δ**) of the synthesized Copper Oxide nanopartices was calculated to be **3.2247m^2**, for the **D** value to be, 32.37nm

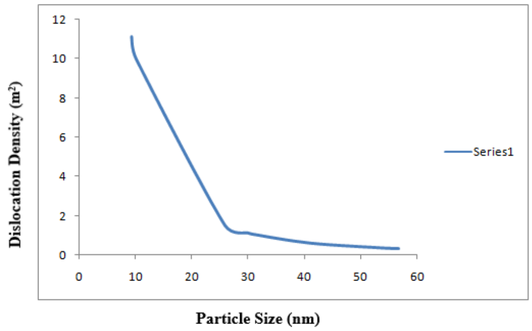

Fig.7: Dislocation Density Vs Particle Size for Copper Oxide nanoparticles

The relation between the Dislocation Density and the particle size of the synthesized Copper Oxide nanoparticles was given in Fig.7. It was observed that, the Dislocation Density was inversely proportional to the particle size. That is, when the dislocation density decreases, the particle size increases. Appearance of dislocations vigorously influences various properties of the synthesized nano material.

Number of Unit Cells:

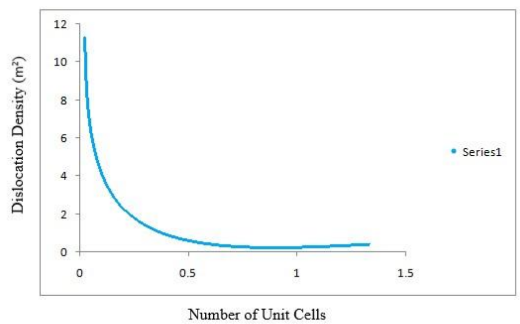

Fig.8: Dislocation Density Vs Number of Unit Cells for Copper Oxide nanoparticles

The smallest group of atoms and molecules whose repetition at normal intervals in the three dimensions exhibits the lattices in a crystal. These unit cells were significant for two reasons. First, number of metals, ionic compounds and intermetallic compounds crystallize in the cubic unit cells. Second, it was comparatively easy to do calculations with these unit cells because the cell edge lengths were all the same with the cell angles. The Number of Unit Cells exhibits in the synthesized Copper Oxide nanoparticles was determined by the expression [21].

$$N = \pi(4/3)\times(D/2)^3\times(1/V)\times10^5 m$$

The Number of Unit Cells exhibits in the synthesized Copper Oxide nanoparticles was calculated to be **6.18×10^5 m**, for the **D** value to be, 32.37nm and for the **V** value to be, 1nm.

The relation between the Dislocation Density and the number of the unit cells in the synthesized Copper Oxide nanoparticles was given in Fig.8. It was observed that, the Dislocation Density of the synthesized Copper Oxide nanoparticles was inversely proportional to the number of unit cells present in the synthesized Copper Oxide nanoparticles. That is the dislocation density of the material decreases, as the number of unit cell increases.

Morphology Index:

The Morphology Index of a Crystal was exhibited as the set of crystallographic planes that exhibits on the crystal apparent. The morphology Index was significant for two reasons. First, the crystalline fashion was not confined with the Miller Indices of the Crystal surfaces. Second, the Morphology Index expresses the Peak Overlapping Effect. The Peak Overlapping Effect was expressed as the area of one peak adjoined into another peak. Fig.6. exposes that the X-Ray Diffraction of synthesized Copper Oxide nanoparticles. There was no evidence for the Peak Overlapping Effect. Morphology Index of the synthesized Copper Oxide nanoparticles was calculated by given expression[21]. These values are taken from Full Width at Half Maximum values of X-Ray Diffraction Data.

Morphology Index = $FWHM_h$ / [$FWHM_h$+$FWHM_p$] Units

Morphology Index of the synthesized Copper Oxide nanoparticles was calculated to be 6.0324 Units, for the **$FWHM_h$** value to be, 0.8029º and for the **$FWHM_p$** value to be, **0.1506º**.

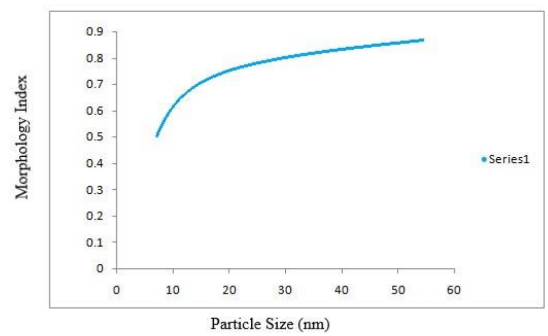

Fig.9: Particle Size Vs Morphology Index for Copper Oxide nanoparticles

The relation between the Particle Size and Morphology Index for the synthesized Copper Oxide nanoparticles was given Fig.9. It was observed that, the

Particle Size of the synthesized Copper Oxide nanoparticles was directly proportional to the Morphology Index of the synthesized Copper Oxide nanoparticles. That is particle size increases, the Morphology Index also increases.

IX. ENERGY DISPERSIVE X-RAY ANALYSIS

The result of Energy Dispersive X-Ray Spectroscopy delivers an understanding about the elements existing in the green synthesized nanoparticles. The Energy Dispersive X-Ray profile of green synthesized Copper Oxide nanoparticles displays the signal of the Copper and Oxygen atoms of the sample was shown in Fig.10.

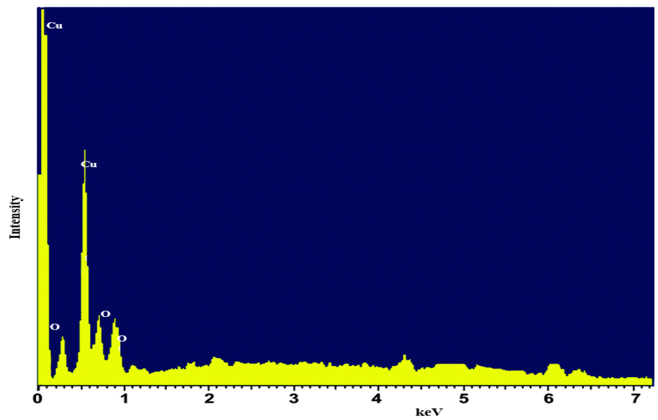

Fig.10: EDX Spectrum of synthesized Copper Oxide nanoparticles

This was evitable that the prepared sample was CuO (Copper Oxide). From the EDX Spectrum, Fig.10. established that the perfect formation of Copper Oxide nanoparticles with the leaf extract of *Solanum Nigrum*. The perpendicular axis brings to view the number of X-Ray counts and the parallel axis displays Energy in KeV. The existence of elemental Copper and Oxygen could be detected in the spectrum conferred by Energy Dispersive X-Ray Spectroscopy that illustrates the minimization of Copper ions to elemental Copper and Oxygen ions to elemental Oxygen. The strong intensity of diffraction peaks points out that highly crystalline nature of synthesized Copper Oxide nanoparticles. Therefore Energy Dispersive X-Ray Spectrum bring to an end that the green synthesis performed a deep role in regulating the particle size. The molecular weight constitution of Copper (Cu) was 56.18% and the atomic constitution was 54.06%. The molecular weight constitution of Oxygen (O) was 43.83% and the atomic constitution was 45.94%. This result was closely agreement with synthesis of Copper Oxide nanoparticles by simple chemical route by Jyothi Mayakar et al. According to their EDX report elemental constitution of Copper and Oxygen were 40.73% and 59.27% respectively [12].

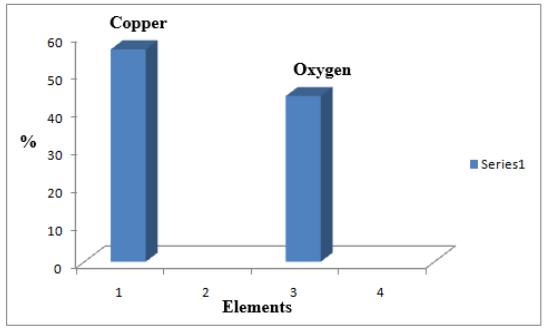

Fig.11: Quantitative Analysis of synthesized Copper Oxide Nanoparticles

The quantitative analysis of Copper Oxide nanoparticles was given above Fig.11. This data were extracted from Energy Dispersive X-Ray Spectrum. According to this analysis it was observed that synthesized sample contains maximum amount of Copper (56%) and Oxygen (44%).

X. SCANNING ELECTRON MICROSCOPE ANALYSIS

To determine the surface morphology of the synthesized Copper Oxide nanoparticles was closely examined under Scanning Electron Microscope. The Scanning Electron Microscope images of the green synthesized Copper Oxide nanoparticles using the extract of leaves of *Solanum Nigrum* was shown in Fig.12.

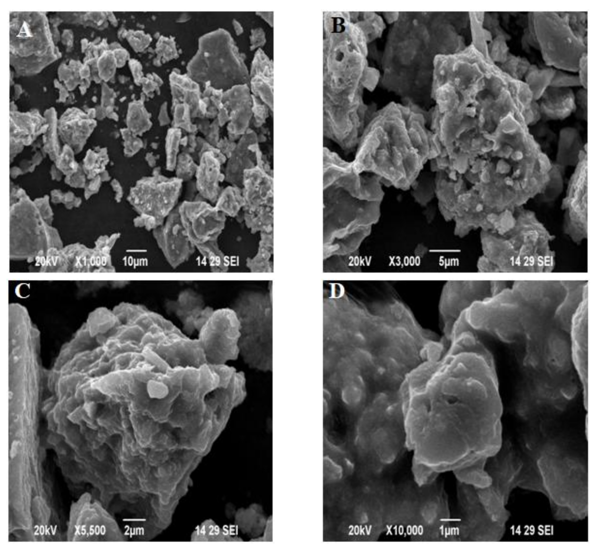

Fig.12: SEM images of synthesized Copper Oxide nanoparticles

According to, the Scanning Electron Microscope images, designates that synthesized Copper Oxide nanoparticles sizes were in nanometer range. The structure of the synthesized Copper Oxide nanoparticles was not homogenous. That is the shape was crumbled and scattered. Due to agglomeration, on the account of the sticking nature, regarding morphology of anomalous appearance of the synthesized Copper Oxide nanoparticles. In Fig A, synthesized Copper Oxide nanoparticles does not delineate with each other. Several particles were originates diminutive in size and certain particles were originates immense in size. Fig B, In this position synthesized Copper Oxide nanoparticles do not possess polished surfaces. On the whole it seems to have rough surfaces. The prepared Copper Oxide nanoparticles had no evidences for the presence of Capping Agents. This variation in size and shape of the prepared Copper Oxide nanoparticles by green synthesis methods were common.

XI. FOURIER TRANSFORM INFRA-RED RADIATION ANALYSIS

The Fourier Transform Infra-Red Radiation Spectrometer was used to interpret the various functional groups present and also determine the absorption range in the *Solanum Nigrum* leaf extract. The Fourier Transform Infra-red Radiation Spectra of synthesized Copper Oxide nanoparticles was given in Fig.13. According to the spectrum the peak values of absorption between 400cm^{-1} to 1600cm^{-1}. There was no observable absorption between 1600cm^{-1} to 3750cm^{-1}.

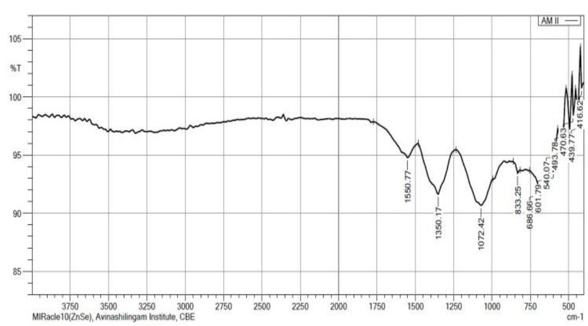

Fig.13: FTIR absorption Spectrum of synthesized Copper Oxide nanoparticles

The absorption peaks 416.62cm^{-1}, 439.77cm^{-1}, 470.63cm^{-1}, 493.78cm^{-1} were corresponds to C-Halogen stretching of Halogen Compounds [34]. The absorption peaks 540.07cm^{-1} and 601.79cm^{-1} corresponds to –NH Stretching and –NH Vibration of Aliphatic Amines. The absorption peak 686.66cm^{-1} corresponds to =C-H Stretching of Aromatic Compounds [36]. The broad absorption peak 1072.42cm^{-1} corresponds to C-H Stretching of Alkane compounds[33]. The absorption peak 1350.17cm^{-1} corresponds to =C-H stretching of Aromatic Compounds and the broad absorption peak 1550.77cm^{-1} corresponds to C=N stretching of Unsaturated Amino acids[36]. Fourier Transform Infra-Red Radiation Spectrum reveals that the green synthesized Copper Oxide nanoparticles was surrounded by different organic compounds like Amines, Halogens, Alcohols, Aromatics and Amino Acids. From the Fourier Transform Infra Red analysis make that the amine group from the amino acid residue, aromatic compounds and phytochemical compositions has a vigorous efficiency to restrict the metal nanoparticles as the capping of Copper Oxide nanoparticles to impede the accumulation and in consequence of that sustains the medium. This recommends that bio molecules could perhaps to execute the binary objectives of construction and equalization of Copper Oxide nanoparticles in the liquefied medium. Hydro dispersible heterocyclic groups like, Alkanes and Aromatic were most liable for the contraction and equalization of nanoparticles. This conclusion involved that Alkanes, Aromatic, Halogen, Aliphatic Amines and Amino acids exists in *Solanum Nigrum* leaf extract exhibit a greater appearance in the contraction of Cu^{2+}atom [20].

XII. CONCLUSION

In this current research, the Copper Oxide nanoparticles are synthesized by *Solanum Nigrum* leaf extract by Sol-Gel method. Synthesized Copper Oxide nanoparticles were characterized by following analyses methods. UV-Vis Spectrum present to views the maximum absorption peak of Copper Oxide nanoparticles around 350nm and the Band Gap Energy was calculated to be 3.54eV. The X-Ray Diffraction analysis confirmed that the particles are in nanometer ranges with crystalline phase and the particle size was calculated to be 32.37nm. Scanning Electron Microscopy analysis exposed that the synthesized Copper Oxide nanoparticles were irregular shaped in structure. The Energy Dispersive X-Ray analysis Exposed that the presence of maximum amount of Copper and Oxygen in the prepared sample. The Fourier Transform Infra Red spectrum exposes that the main functional groups present in the synthesized Copper Oxide nanoparticles.

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