

## SYNTHESIS OF CUO NANOPARTICLES BY CO- PRECIPITATION METHOD

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Crossref DOI - <https://doi.org/10.63665/rh.v7i2.96>

### **Abstract :**

*This abstract describes the successful synthesis of monoclinic copper oxide (CuO) nanoparticles using a simple and cost-effective co-precipitation method. The procedure involved dissolving a Copper (II) Chloride precursor, in deionized water and subsequently adding an alkaline solution, like sodium hydroxide (NaOH), dropwise under continuous magnetic stirring to achieve a specific pH (typically pH 8-12). The reaction leads to the formation of a black precipitate, which is then repeatedly washed with deionized water and ethanol to remove any residual impurities and by-products. The resulting precipitate is dried in a hot air oven and then calcined at an elevated temperature to obtain the crystalline CuO powder.*

**Keywords :** CuO nanoparticles, Co-precipitation, XRD.

### **Introduction :**

Nanoscience and nanotechnology represent one of the most transformative fields of research in the 21st century, offering immense potential across diverse domains such as medicine, electronics, energy, and environmental science. At the heart of this field lies the study and manipulation of materials at the nanoscale, typically within the range of 1 to 100 nanometres (nm). These advancements have opened new avenues for technological innovation, making nanotechnology a key enabler in solving complex challenges in fields such as renewable energy, advanced materials, and precision medicine. Research in nanotechnology has been driven by the need to miniaturize devices and improve their efficiency [1]. The discovery and synthesis of nanomaterials, such as carbon nanotubes, graphene, and metal oxide nanoparticles, have propelled this field forward. Among these, metal oxide nanoparticles like copper oxide (CuO) are particularly significant due to their multifunctionality and wide range of applications in catalysis, optoelectronics, and biomedicine [2]. This thesis delves into one aspect of this burgeoning field: the synthesis and characterization of CuO nanoparticles. By employing the precipitation method, this study aims to contribute to the growing body of knowledge in nanoscience, with potential implications for practical applications in various industries [3].



## **Materials and methods :**

### **Materials used :**

Copper (II) salt (commonly copper (II) nitrate, or copper (II) chloride), analytical grade. Precipitating agent such as sodium hydroxide or ammonium hydroxide. Distilled or deionized water. Ethanol (optional, for washing). Glassware (beakers, stirrer, centrifuge tubes, etc.)

### **Synthesis of CuO :**

#### **Synthesis of CuO by Co-precipitation :**

Copper oxide nanoparticles can be obtained by generating a metal-hydroxide precursor in aqueous solution and converting it to CuO through controlled heating. Preparation of precursor solution. A copper (II) salt is dissolved in distilled water to form a homogeneous aqueous solution containing  $\text{Cu}^{2+}$  ions. Formation of precipitate a basic solution (e.g., NaOH or  $\text{NH}_4\text{OH}$ ) is added slowly to the copper solution under continuous stirring. The addition of base increases the pH, causing the formation of a copper hydroxide precipitate. Stirring is maintained to ensure uniform nucleation. Aging, the resulting suspension is allowed to stand or continue stirring for a suitable period. This aging step promotes completion of the precipitation reaction and improves particle uniformity. Separation and washing: The precipitated solid are separated from the solution by centrifugation or filtration, then washed several times with distilled water (and optionally ethanol) to remove residual ions. The washed precipitate is dried at a moderate temperature to remove moisture. Copper chloride dihydrate deionized\_water, and sodium hydroxide were used to prepare the CuO samples. All samples were acquired from local suppliers in their analytical grade. No additional purification processes were applied to the samples. A conventional method was employed for the synthesis of copper\_oxide (CuO) nanoparticles.

## **Result and discussion :**

### **XRD Analysis :**

The purity and crystallinity of the as-synthesized CuO nanoparticles were examined by using powder X-ray diffraction (XRD) as shown in Figure1. It can be seen from that the diffraction peaks are low and broad due to the small size effect and incomplete inner structure of the particle. All these diffraction peaks can be perfectly indexed to the face-centred cubic (FCC) crystalline structure of CuO, not only in peak position, but also in their relative intensity of the characteristic peaks, which is in accordance with that of the standard spectrum (JCPDS, No.). The XRD pattern shows that the samples are single phase and no any other impurities distinct diffraction peak except the characteristic peaks of FCC phase CuO was detected. This result shows that the physical phases of the CuO nanoparticles have higher purity prepared in this work.



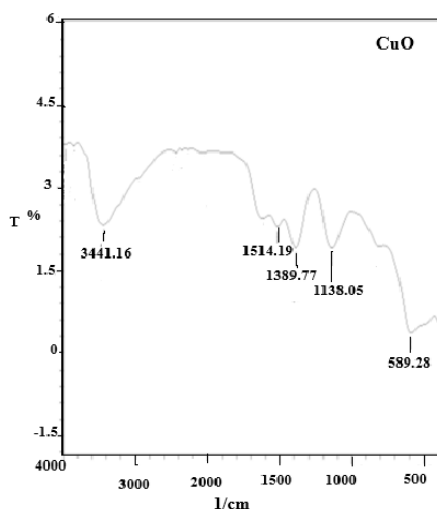


Fig.1 XRD Spectra

**FTIR Analysis :**

To understand the dominant functional group present in the catalyst FTIR was recorded at room temperature. The FTIR spectra of NPs are as shown in fig. From the FTIR spectra peak around the 1550 and 3439 cm<sup>-1</sup> is because of the nickel oxygen bond stretching vibrations. The broadness of a peak indicates that the CuO catalyst is crystalline in nature. The absorption band at 138.97 and 1514.19 cm<sup>-1</sup> is due to the symmetric stretching mode of vibrations of CO<sub>2</sub> molecule absorbed from the air. Also, the broad peak 3441.16 cm<sup>-1</sup> is may be because of stretching and bending vibrations of -OH group absorbed on catalyst surface from the atmosphere when FTIR analysis was carried out.

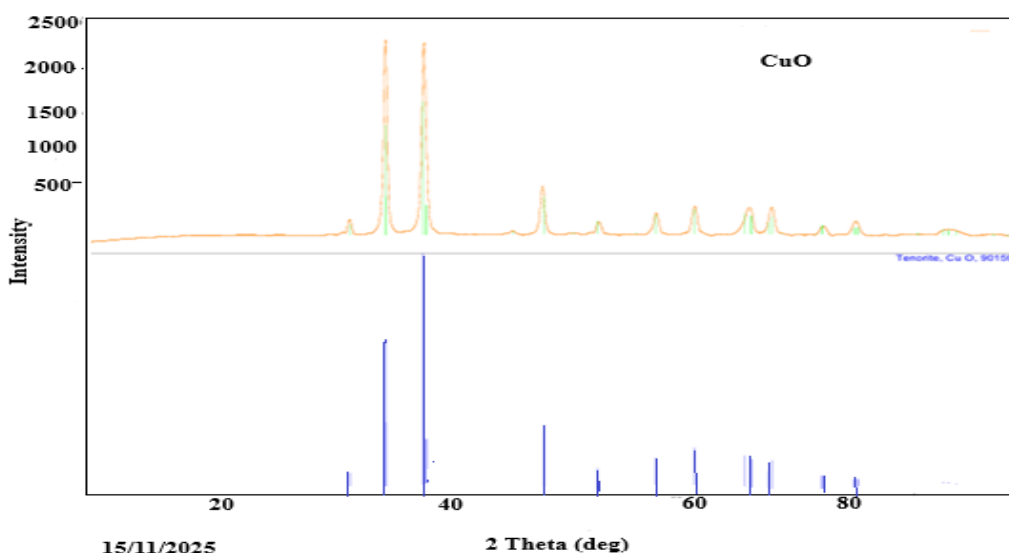


Fig2. FTIR Spectra

## Conclusion :

In conclusion, our study has successfully established the synthesis of CuO nanoparticles utilizing the precipitation method. In order to create CuO nanoparticles, solution of potassium hydroxide and zinc nitrate are carefully mixed under specified circumstances. The resultant nanoparticles show encouraging traits like excellent crystallinity, tiny size, and great purity. CuO nanoparticles synthesis has been successfully confirmed by characterization methods as, Fourier transform infrared spectroscopy, and X-ray diffraction. The unique characteristics of the produced CuO nanoparticles by precipitation process is an easy, affordable, and scalable way to create CuO nanoparticles. In conclusion, the precipitation approach of CuO nanoparticles synthesis presents a promising path towards the creation of sophisticated materials with wide range of uses. In addition to advancing nanotechnology, more research in this field will open the door to creative responses to pressing global issues. XRD and FTIR are fundamental characterization techniques for CuO nanoparticles. XRD provides detailed information about the crystal structure, phase purity, and crystallite size, while FTIR reveals chemical bonding and surface functional groups.

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