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Synthesis of copper oxide nanoparticles via sol-gel method

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Abstract

Recently copper oxide nanoparticles attracted the investigators due to their significant characteristics and employment in semiconductors, magnetic storage media, solar energy transformation, near-infrared tilters, high-tech superconductors, gas sensors, photoconductive and photothermal devises. Copper oxide nanoparticles are the semiconductor materials having band gap energy 1.2 eV. In the present study Copper oxide nanoparticles were synthesized by sol gel method using $CuCl_2.2H_2O$ and sodium hydroxide as precursors. The structure and morphology of synthesized copper oxide nanoparticles was investigated utilizing of X-ray diffraction (XRD) spectroscopy and Scanning Electron Microscopy (SEM).

Keywords: Copper Oxide Nanoparticles, Sol-Gel method

1. Introduction

Technologists that relating to nanomaterials become novel branches of sciences which deals with 1-100 nm of materials sizes and having various crystal shapes like spherical NPs (nanoparticles), Nanorods (flower), Nanoribbons and Nanoplatelets. The matchless physio- chemical properties were results from aria with high surface comparing with bulk one [1-4]. In the development of Nano size materials of metal and metal oxides particles are intensively pursued because of their prominence in different fields of applications in science and technology. All the transition metal oxides, CuO is a potential candidate for magnetic storage devices, solar energy transfer, sensors, and super capacitors and especially it acts as a good catalyst in some of the chemical reactions [5]. Copper oxide act as material with semiconductor characteristics and were natural abundance of starting materials. Copper oxide NPs were non-toxic and obtained easily through the oxidation reaction of copper. CuO is one of the significant metal oxide that recently attracted investigators due to availably and low cost, in addition to peculiar characteristics [6]. Several methodologies were employed to prepared copper oxide NPs. These comprise; rapid precipitation coating, solid state reaction, chemical deposition, sono-chemical reaction, sol chemical bath deposition, solvo-thermal process, electrochemical technique thermal oxidation, spray pyrolysis, and hydrothermal. [7] sol gel technique have many beneficial. Solitary sol-gel installation could produce materials with ultra-temperatures, synthesize nearly any substance, and co-synthesize two or more substances with each other [8]. Materials-NPs having significant properties, that remarkably varied from bulk one [9-15] so that our investigation, represent a simple methodology for description of the synthesis of copper oxide NPs by using of sol-gel technique.

2. Materials and Methods

2.1. Materials

The starting materials and solvents were purchased from Sigma Aldrich and ChemAR, without further purification. The X-Ray Diffraction spectrum for the nanomaterials were recorded on a X-Ray-STADI P(STOE/Germany). Scanning Electron Microscope was performed using SEM 54032-GE02-0002/8038 (MIRA3/Austria) which is a SEM system with the sputter coater device with gold.

2.2. Synthesis of copper oxide Nanoparticles

Copper oxide nanoparticles were prepared via sol-gel method using glacial acetic acid (1 mL) that added to stirred solution of $CuCl_2.2H_2O$ (0.2 M). The solution was heated to 100 °C. Sodium hydroxide (8 M) was added to the stirred solution to make pH equal to 7. The color of the stirred solution turned to black from green immediately and the large amount of black precipitate is formed immediately. Centrifuged and washed the precipitate several times with de-ionized water under vacuum, and dried at room temperature.

3. Results and discussion

Various techniques have been employed for the synthesis of copper oxide NPs such as, solid state reaction, sol-gel, thermal decomposition and microwave irradiation. The sol-gel methodologies have the ability to synthesis materials NPs at room temperature, can produce most of the metals and accurately control the chemical and physical characteristics.

3.1. Scanning electron microscopy (SEM)

The surface morphologies of the synthesized copper oxide nanoparticles have been examined through scanning electron microscopy. Figs. 1 and 2 show the SEM images copper oxide respectively with the nanostructures clearly visible. The effect of reaction time plays a marvelous role in the morphology of nanoparticles.
Figures 1 and 2, demonstrated a heterogeneous distribution of the synthesized copper oxide Nano particles.

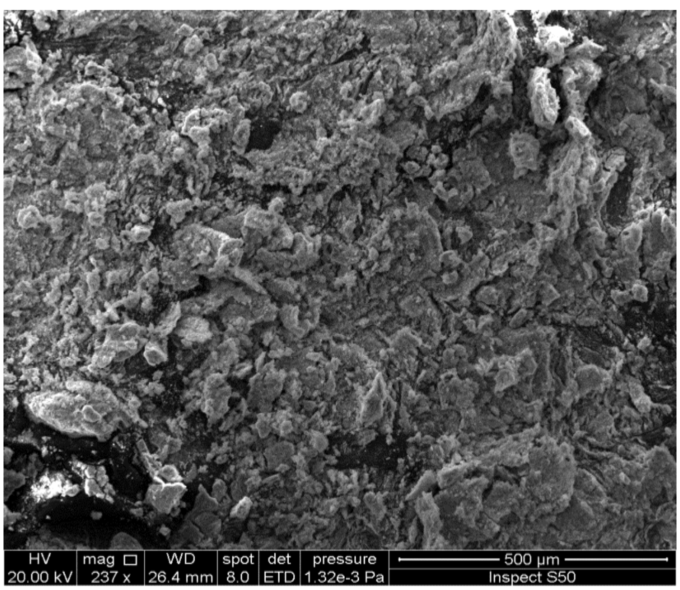

Figure 1: SEM image of CuO Nano particle (237x).

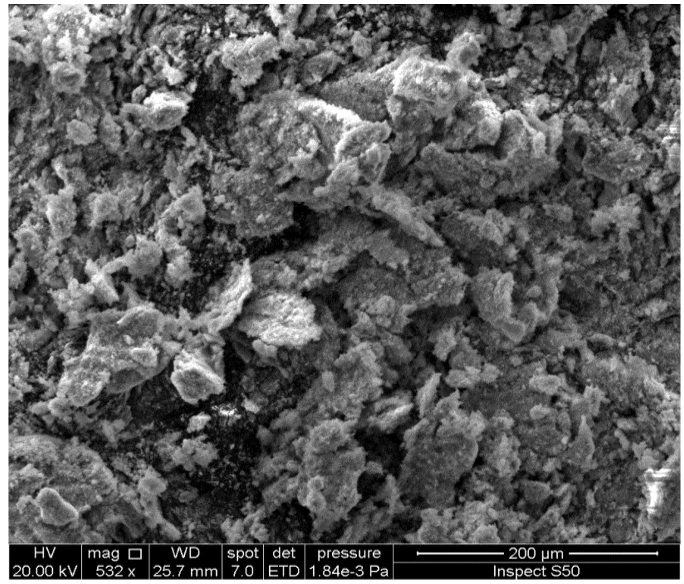

Figure 2: SEM image of CuO Nano particle (532x).

3.2. XRD

Structural investigation of copper oxide nanoparticles by XRD. The XRD pattern for the copper oxide nanoparticles is shown in Fig. 3 respectively and indicates a single-phase with a monoclinic structure. The peak intensities and positions agree well with the library data.

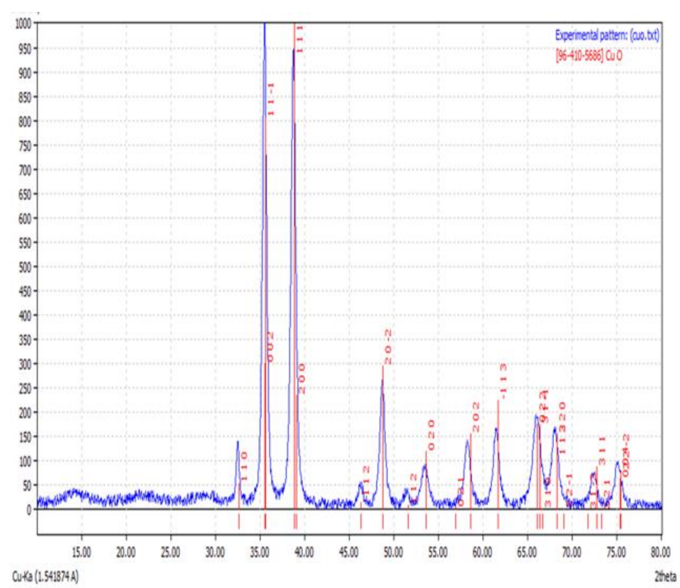

Figure 3: XRD for copper oxide Nanoparticles.

4. Conclusion

Copper oxide nanoparticles were prepared by sol gel method. Mole ratio plays an important role in controlling the size of the copper oxide nanoparticles. The grain size of copper oxide in this method was 16 nm. With increasing the concentration of the base, the particles size becomes smaller.

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