Optical Characterization and Surface Morphology of Copper Nanoparticles on Borosilicate Glass

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Abstract

Copper oxide nanoparticles are of interest on account of their potential uses in many technological fields especially in solar field. Nanostructured copper oxide thin film (CuO) was prepared on borosilicate glass tube via sol–gel deep coating method started from Cupric Acetate with colloidal solution in water. Film was prepared by dip coating under room conditions (temperature, 27–38°C) and annealed in furnace at 250 °C for one hour then cooled in the furnace for 12 hours. The products were characterized by X-ray diffraction (XRD), Transmission Electron Microscopy (TEM) and UV-visible spectrum.

Keywords: CuO nanoparticles, Sol-gel method, Borosilicate glass.

Introduction

Nanomaterials exhibit unique morphological and optical properties, which are different to that at their bulk level. Synthesis of nanomaterials comprises mainly wet chemical or physical routes with less involvement of biological methods [1]. CuO is attractive as a selective solar absorber since it has high solar absorbency and a low thermal emittance. This unique property of CuO which acts as a semiconductor and due to favourable band gap it is very much useful for photo thermal conversion system [2].

Of all kinds of synthesis process, the sol-gel method has many advantageous. Only sol-gel synthesis can produce materials at low temperatures, synthesize almost all kinds of materials, co-synthesize two or more materials simultaneously and precisely control the microstructure of the final products [3].

In the synthesis process glass substrate plays vital role in its optical and electronic properties. Here in this communication Copper nanoparticles are deposited on glass substrate by deep coating synthesis technique. Formation of Copper nanoparticles is confirmed using XRD, TEM and UV-VIS analysis. From that it is concluded that synthesised copper nanoparticles are in the range of 5 to 7 nm.

Experimental

The synthesis of copper nano-particles with controllable sizes, shapes and surface properties is vital for exploring copper nanoparticles for different industrial applications. One of the most important methods for the grown copper nanoparticles on glass substrate is the deep coating deposition. In this Communication we prepared copper nanoparticles with controlled size of ~ 5nm using the faster and cost effective Sol-

gel technique, in which solution were prepared by acetate rout, copper salt was taken as starting materials which dissolved in acid and distilled water with 1:1 ratio with 0.6 molarity, precursor was the stirrer using magnetic stirrer at 400rpm for 1hrs at 60°C to prepare a solution. This solution was heated at 80°C temperature for 1hrs and 40minit to get gel.

This gel used for deep coating process, glass substrate first clean by hot distil water and cleaning agent mixture then put in bath of acetone for 1 hrs and clean by ultrasonic cleaner and dry in oven at 150oC for 2hrs. Clean glass substrates are kept inside the deep coater for 10 minute for deposition then dry at 200oC temperature for 1hrs.

XRD-measurement obtained on nano copper particles deposited on borosilicate glass using Model: Xpert MPD, Make: Philips.TEM micrographs were obtained on Tecnai 20, Make: Philips, Holland. UV-visible spectra were measured by Lanbda 19, Make: Perkin Elmer, U.S.A.

Results and Discussion

The XRD pattern of nanocopper particles deposited on glass substrate are shown in figure 1, which depicts the diffraction peaks attributed to the Cu phase (JCPDF File no.04-0836. The grain size of nanoparticles estimated by Scherrer's formula.

$$CS = \frac{0.9\lambda}{\beta Cos}$$

Where λ is the X-Ray wavelength and FWHM (Full Width at Half Maximum) is broadening while θhkl is the brag angle of diffraction peak.

The XRD Study confirms that the resultant particles are (FCC) Copper Nanoparticles. The crystallite size of copper nanoparticles is calculated using equation (1) and found to be around 5 to 7 nm which is in good agreement with the particle size measured from TEM image (Figure 2).

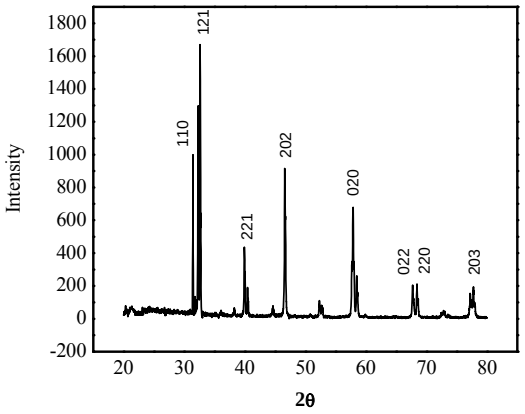

Fig. 1 XRD pattern of nanocopper particles deposited on glass substrate.

TEM Analysis:

TEM micrograph of copper nanoparticles and their size distribution is shown in Figure 2. Which displays spherical nanocopper particles with sizes ~ 6 nm. Also, it is clear that, almost all particles have same size, which indicating uniform growth of copper nanoparticles deposited on glass substrate by deep coating deposition.

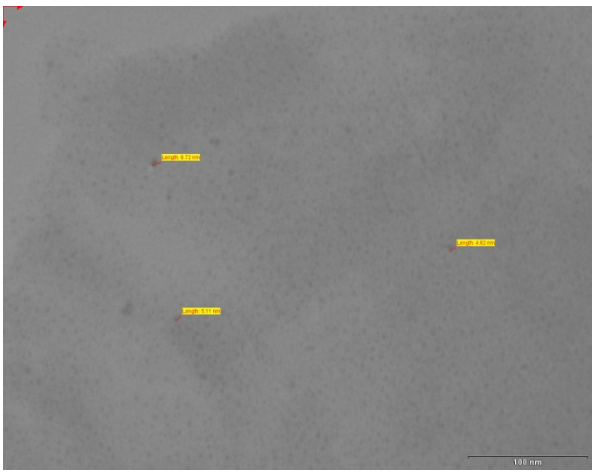

Fig. 2 TEM Image of copper nanoparticles deposited on glass substrate.

UV-visible spectroscopy

UV-Vis absorbance spectroscopy has proved to be a very useful technique for studying metal

nanoparticles because the peak positions and shapes are sensitive to particle size.

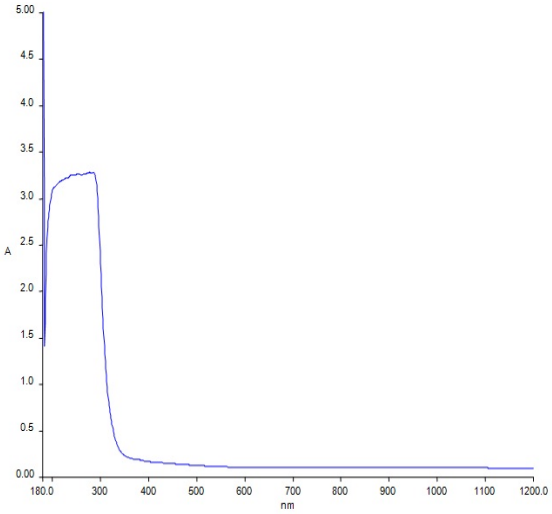

Fig. 3 UV-VIS Spectroscopy of copper nanoparticles

Here UV-visible spectroscopy was applied to determine whether the synthesized particles were metallic copper. Colloidal dispersions of metals show absorption bands or broad regions of absorption in the UV-visible range due to the excitation of plasma resonances or interband transitions, characteristic properties of the metallic nature of the particles. It is reported that plasmonic absorption near 300nm peak corresponded to Cu nanoparticles . Same spectra effect can observed in the Figure 3, which further conform the formation of Cu nanoparticles.

Conclusions

Here, in this communication, one of cheapest method is described to deposited copper nanoparticles (5 to 7 nm) on borosilicate glass substrate. This method does not require organic solvents, expensive raw materials and complicated equipment. Also phase purification is confirmed by the XRD and UV-Visible spectrometry data.

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