

Fabrication of Cadmium Nanowires By Electrodeposition Method

Samiksha Mehta

Department of Physics, I.E.T, Alwar

E-mail: samikshamehta25@gmail.com

Abstract: Cadmium (Cd) nanowires have been synthesized by electrodeposition method with in confined nanochannels of polycarbonate porous membrane. Cadmium nanowires are highly conductive and cheaper in cost. Cadmium nanowires were fabricated by using the membranes of diameters of 100 nm. The characterization of nanowires was done by X-Ray diffraction and I-V analysis.

Keywords: cadmium electrodeposition, nanowires, templates and membranes.

Introduction: Recently, one-dimensional (1D) nanostructures have attracted considerable attention owing to their novel physical and chemical properties and the potential applications in a new generation of nanodevices [1-3]. Nanowires are especially attractive for nanoscience studies as well as for nanotechnology applications. Nanowires, compared to other low dimensional systems, have two quantum confined directions, while still leaving one unconfined direction for electrical conduction. This allows nanowires to be used in applications where electrical conduction, rather than tunneling transport, is required. Cadmium is one of the important metals in modern electronic technology [4]. Many methods have been developed for the fabrication of cadmium nanowires but template synthesis is considered to be the most suitable and useful for growth of nanowires. Cadmium (Cd) is an important heavy metal used in the nuclear reactors because of their tendency to absorb low energy neutrons. The rods of Cd or its alloys are used for controlling the fission process in nuclear reactors [5]. The 1D nanostructures of several cadmium compounds, such as CdS, CdSe, and CdTe have been synthesized and studied extensively [6–7].

Experimental Details: Cadmium nanowires are synthesized by template based [8-9] technique using polycarbonate membranes [10-11]. In this technique, polycarbonate membranes with cylindrical nanopores of diameter 100 nm are used. A simple principle of electro-deposition is used to fill the pores of template on cathode using two electrode system. Utilizing the process of

electro-deposition [12], free standing Cd nanowires are synthesized on Cu substrate, which acts as cathode during electro-deposition. The electrolyte for Cd nanowires used is solution of CdSO_4 (2.5 gm / 50 ml) and boric acid (1.75 gm / 50 ml). The anode is a Cd electrode. The electro-deposition has been carried out at potential (0.7 V) at room temperature 40 °C.

Results and Discussion: To study the structural properties, XRD spectra of prepared sample was recorded on a RigaKuC/max-2500 diffractometer using graphite filtered $\text{CuK}\alpha$ radiation ($\lambda = 1.54056 \text{ \AA}$) at 30 kV and 15 mA with a scanning rate of 3°min^{-1} from $2\theta = 30^\circ$ to 80° . Fig. 1 shows the XRD patterns of the Cd nanowires.

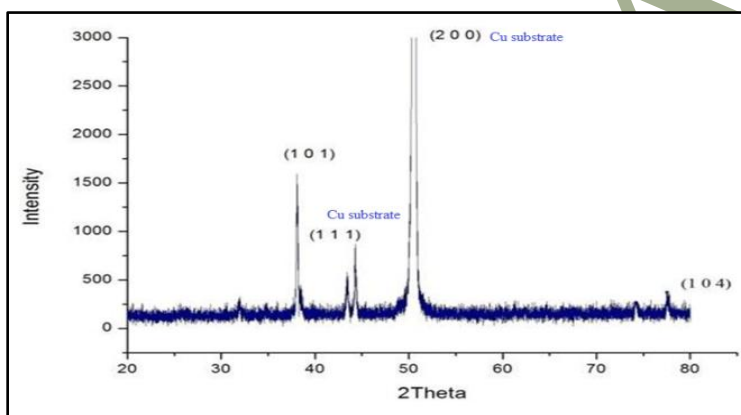


Fig. 1 XRD pattern of Cd nanowires

The position of peaks in the XRD graph confirms that material deposited is cadmium in pores of template. The length of wires is 100 nm as of thickness of template.

Fig. 2 shows the I-V characteristics of Cd nanowires. Electrical conductivity of nanowires can be calculated by using current voltage characteristics. The I-V curves were drawn using a 2-probe system via Keithley 2400 Series Source Measurement Unit by stepping the voltage from -0.5 volts to +0.5 volts. The observed current was in the range of mille-amperes. All the readings were taken at room temperature.

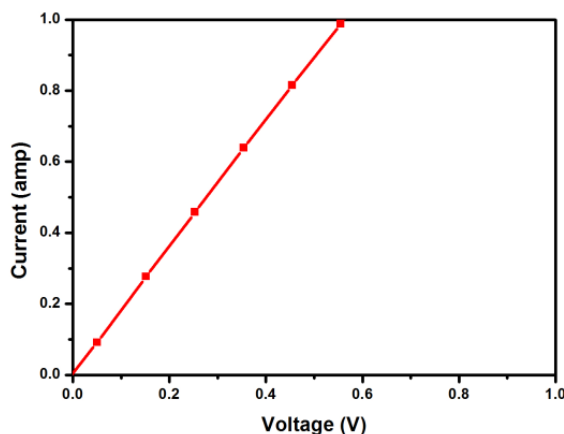


Fig. 2 I-V analysis graph for Cd nanowires of diameter 100 nm

Electrical conductivity of nanowires of diameter 100 nm can be obtained the formulae $\sigma = l/RA$ where l is length of nanowire, A is area and R is resistance. Electrical conductivity of Cd nanowires was found to be $0.064 \times 10^6 \text{ S/cm}$.

Conclusions: Nanowires of cadmium were fabricated by electrodeposition method using template. Cadmium nanowires of diameter 100 nm were fabricated. The XRD confirms the material deposited was cadmium. The electrical conductivity was found to be $0.064 \times 10^6 \text{ Scm}^{-1}$ which shows the conductive nature of cadmium nanowires.

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