



Characterization of Template Synthesised Ag₂S Nanowires

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Abstract: Synthesis and characterization of one-dimensional nanostructures have attracted attention primarily due to their potential myriad applications in different fields including magnetic, electronic and optical devices. There are various techniques used in the fabrication of one-dimensional structures but template synthesis is an elegant, versatile and economic method for synthesizing variety of these one dimensional nanostructures, and so on. Highly ordered Ag₂S nanowires each having 100 nm diameters were synthesised into the pores of anodic alumina membrane (AAM) template by using direct chemical deposition method. The nanowires were deposited using silver nitrate as a Ag⁺ ion source and sodium sulphide as S²⁻ ion source. The nanowires were characterized by Scanning Electron Microscope (SEM) and UV-Vis spectrophotometer to see surface morphology and optical band gap respectively. The as-deposited Ag₂S nanowires embedded in AAM are black in colour and having optical band gap 0.95 eV.

Keywords: Ag₂S nanowires; Anodic Alumina Membrane; Optical band gap

INTRODUCTION

In the past few years, low dimensional structures such as wires, fibers and tubules, have attracted much attention because of their fundamental importance and potential myriad applications in the field of science and technology [1-2]. Many efforts have been made to produce one dimensional nano-structures keeping in mind the fact that electrical and optical properties can be tailored via chemical control over the size and diameter of the structures [3-4]. Semiconductor compound materials in general play important role in band gap engineering mainly due to their special tenability in electronic and optical properties by the three dimensional confinement of carriers. When nano-scale semiconductor materials are fabricated, their density of electronic states will change in systematic manner, which strongly influences the electronic and optical properties of the materials. Furthermore, nano-sized semiconductor material particles exhibit some unique properties such as quantum confinement effect, nonlinear optical properties and some other physical and chemical properties, besides their potential applications in research and development of nano-devices [5-10].

There are various techniques used in the fabrication of nanostructures. Template synthesis is one of them which is a versatile and economic tool for synthesizing the variety of nanomaterials including metals, semiconductors, heterostructures, conducting polymers, CNTs etc.. The structures generated by this technique may be homogeneous or heterogeneous (including long needles, tubules, tapered and conical etc.) depending on the pore size, shape and geometry of the template used with complete control over aspect ratio [11-12, 16].

We report here a non-galvanic method (chemical method) for synthesis of ordered and crystalline arrays of Ag₂S nanowire using AAM as template sandwiched between a two-compartment cell as described below. AgNO₃ is employed as Ag⁺ source and Na₂S employed as S²⁻ source. The nanowires are characterized by SEM and UV Visible spectrophotometer.

EXPERIMENTAL

The AAM (anodisc-21, Whatman, UK) with pore diameter 100 nm was used as template for the fabrication of ordered Ag₂S nanowires. All the chemical reagents used were RA grade and without further purification. AgNO₃ and Na₂S were procured from s.d.fine-Chem Ltd. Mumbai, India. All solutions were prepared in de-ionized water. The AAM template was fitted in a paired cell in such a way that it separated the cell in two chambers (Figure 1). For the deposition of Ag₂S nanowires, one chamber was filled with 100 mM solution of AgNO₃ (pH = 4) and other was filled with 50 mM solution of Na₂S. The morphological characterization of Ag₂S nanowires was examined through SEM by first liberating them from the matrix by dissolving AAO template in 1M NaOH solution at 25°C for 1 hr followed by subsequent washing. The cleaned and dried sample

was mounted on specially designed aluminum stub with the help of the adhesive tape, coated with a thin layer of gold using JEOL, FINE SPUTTER JFC-1100 sputter coater and viewed under JEOL, JSM 6100 SEM.

RESULTS AND DISCUSSIONS

The possible mechanism of formation of Ag_2S nanowires from aqueous solution in two chambers of a cell may be represented as

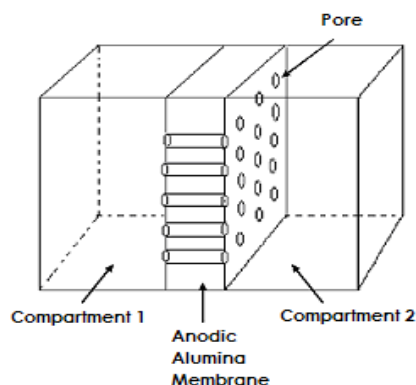
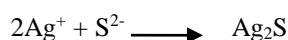
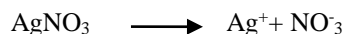


Figure1 . A two-compartment cell with AAM sandwiched between the two compartments.

In one compartments of the cell (Figure 1), the Ag^+ precursor solution AgNO_3 releases Ag^+ ions while in the other compartment, the anionic precursor solution Na_2S hydrolysis to give S^{2-} . In the pores of AAM, Ag^+ combines with S^{2-} to give Ag_2S precipitates. When the cell is left for adequate time (about 12 hrs), the above process continues till the pores are completely filled with the Ag_2S nanowires.

Figure 2 shows SEM image of Ag_2S nanowires. It can be seen that diameter of nanowires is about 100 nm that closely corresponds to the diameter of pores of the template used and also all the Ag_2S nanowires have uniform parallel orientation, diameter and direction of growth which is due to the ordered template pores in AAM template. Figure 3 shows Tauc plot of Ag_2S nanowires. The optical band gap of Ag_2S nanowires is estimated from Tauc plot [13-15]. The optical band gap obtained from this fit is 0.95 eV,

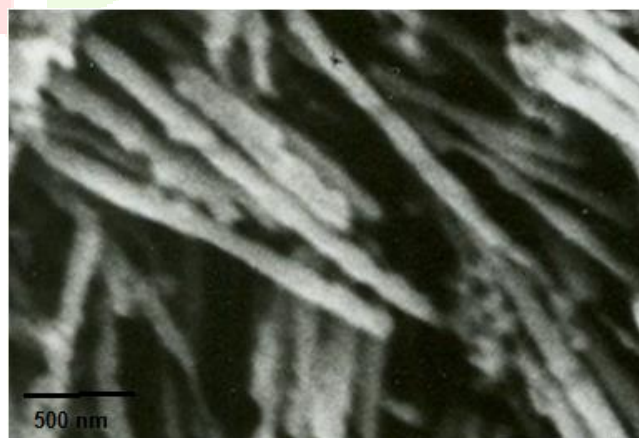


Figure 2. SEM image of Ag_2S nanowires each having diameter of 100 nm.

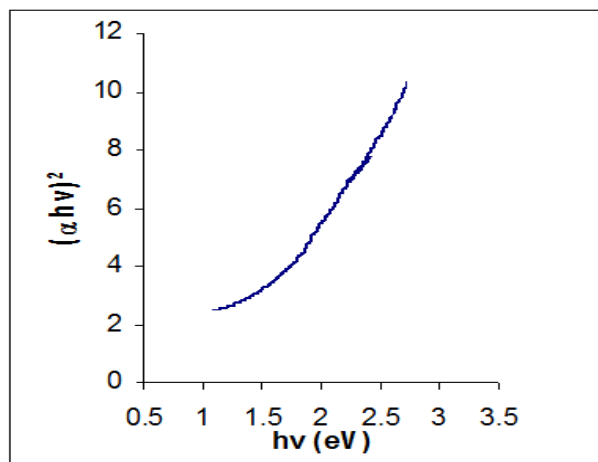


Figure 3 . Tauc plot of Ag₂S nanowires showing 0.95eV band gap

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