Synthesis and Characterization of Uniformly-Aligned MoO₃ Nanobelts

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Abstract—We have been synthesized MoO₃ nanobelts by thermal chemical vapor deposition. The growth products will be studied by field emission scanning electron microscope (FESEM), X-ray photoemission (XPS), Raman Spectroscopy, X-rays diffraction (XRD). SEM images showed the belts-like nanostructures. XPS and Raman shift showed the consisting of MoO₃ structure. XRD patterns indicated orthorhombic MoO₃ structures phase of planes (020), (110), (040), (021), (060) and (010).

Keywords—MoO₃ nanobelts; thermal chemical vapor deposition; raman spectroscopy; XPS; XRD

I. INTRODUCTION

Molybdenum trioxide (MoO₃), a wide band gap n-type semiconductor is interested due to its structures crystal [1-3]. It was used in many applications such as hydrogen evolution [4], field emission [5], thin film transistor [6], capacitor [7] and gas sensor [8]. MoO₃ nanostructures, belts-like, wires-like, rods-like, nanodiscs, nanoflowers and nanosheets have been synthesized from many processes [2-5, 7-9]. MoO₃ nanowires with uniform in side can be formed on silicon substrates without using any catalyst by providing in two methods, thermal evaporation and oxidation [5]. The ordering MoO₃ nanosheets have been prepared via hydrothermal route using MoO₃ powder and hydroquinone as starting materials, for studying the conductivity mechanism of complex impedance and modulus formalism [8]. MoO₃ nanorods have been prepared using a simple ultrasonic method, for gas sensing high response to NO₂ [9]. Recently, the MoO₃ nanobelts can be synthesized by using ammonium molybdate tetrahydrate mixed with ethylene glycol as a starting solution, centrifugation and sintering of the precipitate, the result showed the α-MoO₃ nanobelts grew with a strongly preferred orientation [10]. In this paper, the MoO₃ nanobelts have been synthesized using MoO₃ powder as starting materials by chemical thermal vapor deposition.

II. EXPERIMENTAL PROCEDURE

The mixing of MoS₂ and S powder (SIGMA-ALDRICH) and SiO₂/Si substrate were put in the alumina boat. The alumina boat was placed on the middle of furnace quartz tube and heated at 700 °C under mixing atmosphere of N₂ and O₂ gas with flow rate of 6 sccm for 1 h. The furnace quartz tube was cooled down to room temperature, nationally. Then, the alumina boat and substrate were taken out. We can observe the different color of formed products on substrate. The heated substrate was investigated by optical microscope (OM), field emission scanning electron microscope (FESEM), X-ray photoemission (XPS), Raman spectroscopy, atomic force microscopy (AFM) and X-ray diffraction (XRD).

III. RESULTS AND DISCUSSIONS

After, the furnace tube was cooled down to room temperature, nationally. The formed products on substrate were characterization by OM, FESEM, XPS, Raman spectroscopy, AFM and XRD. The results show as follows.

The figure 1 show the pictures of OM, FESEM and cross-section of substrate. We can see belts-like of formed products with length of more a few micrometers and width of around
200-500 nanometers. The synthesized materials grew from the bottom of substrate with height of about 21.7 micrometers. The XPS patterns showed the elements consisting of MoO₃ nanobelts.

The XPS curves in Figure 2 revealed the elements consisting of prepared MoO₃ nanobelts with Mo and O atoms, the S atom no appear.

The operating of Raman spectroscopy of MoO₃ nanobelts-like showed principal peaks of 994.2, 818.7, 666.4 and 284.5 cm⁻¹, respectively, and we can observed the interference peak of SiO₂ of SiO₂/Si substrate around 525 cm⁻¹.

Figure 4 showed XRD patterns of MoO₃ nanobelts with plane of (020), (110), (040), (021), (060) and (010). All of peaks correspond with MoO₃ (JCPDS reference card no. 05-0508) [11].

The AFM images in FIGURE 5 show some selected MoO₃ nanobelts. This image reveals the morphology side of formed materials on substrate. The thickness of MoO₃ nanobelts are about 20-60 nanometer.

In summary, The MoO₃ nanobelts can be synthesized by thermal chemical vapor deposition. The XRD, Raman shift and XPS were confirming that MoO₃ nanobelts-as-synthesized, and OM, FE-SEM and AFM images showed the length, width and thickness of MoO₃ nanobelts with few micrometers, 200-500 and 20-60 nanometers, respectively.

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REFERENCES


