Available online at www.sciencedirect.com
SCIENCE DIRECT
Chemical Physics Letters 422 (2006) 165–169
CHEMICAL PHYSICS LETTERS
www.elsevier.com/locate/cplett

Growth of MgO nanowires assisted by the annealing treatment of Au-coated substrates

Hyoun Woo Kim *, Seung Hyun Shim

School of Materials Science and Engineering, 253 Yong Hyun Dong, Nam Gu, Inha University, Incheon 402-751, Republic of Korea

Received 7 January 2006; in final form 14 February 2006
Available online 10 March 2006

Abstract

We synthesized crystalline MgO nanowires on Au-coated substrates by the heating of MgB_2 powders. We carried out the thermal annealing on Au-coated substrates prior to the MgO deposition process, affecting the morphology of the final MgO structures. The produced nanowires were of cubic MgO structures with diameters in the range of 40–200 nm. We discussed the possible growth mechanism. Photoluminescence spectrum of the MgO nanowires under excitation at 325 nm showed a visible light emission.
© 2006 Elsevier B.V. All rights reserved.

1. Introduction

Since the discovery of carbon nanotubes (CNTs), much technological and scientific excitement has been raised by the discovery of various forms of nanostructures [1–4]. Among them, one-dimensional (1D) structures including nanowires, nanobelts and nanowires are supposed to have potential applications to nanoelectronics and optoelectronics, owing to their novel physical properties. Magnesium oxide (MgO) is a typical wide-band-gap insulator, having found many applications as catalysis, additives in refractory, paint and superconductor products, and as substrates for thin film growth [5,6]. Accordingly, many research groups have reported on the synthesis of 1D MgO nanostructures [7–13], however, they generally studied from the viewpoint of the preparation method and characterization.

The CNT growth is known to depend strongly on the characteristics of metal catalyst, although the complete mechanism has not been determined. Therefore, we need to investigate the effect of the substrate material on the growth behavior of MgO nanostructures.

In the present communication, we applied thermal annealing treatment to the Au-coated substrates before we grow the MgO structures by a thermal evaporation of MgB_2 powders. Obtaining the MgO nanowires by controlling the predeposition annealing temperature, we have investigated the structural and photoluminescence (PL) properties of the as-prepared MgO nanowires.

2. Experimental

We employed Au-coated Si substrates. In order to fabricate the Au-coated Si substrates, we used Si as the starting material onto which a Au layer of about 3 nm thick was deposited by ion sputtering (Emitech, K757X). Since our objective was to investigate the effect of Au-coated substrate with respect to its morphology, we have preformed the thermal annealing treatment prior to MgO deposition, in which temperatures were in the range of 300–700 °C for 0.5 h in a flow of nitrogen (N_2) gas (flow rate; 500 standard cm^3/min).

The synthesis process was carried out in a quartz tube. The pure MgB_2 powders and the substrates, respectively, were placed on the lower and the upper holder in the center of the quartz tube inserted into a horizontal furnace. The vertical distance between the powders and the substrate with the Au-coated side downwards, was approximately 10 mm. During the experiment, the furnace was maintained at a temperature of 900 °C with the ambient gas ($Ar + O_2$) being at a constant total pressure of 2 Torr. The typical

* Corresponding author. Fax: +82 32 862 5546.
E-mail address: hwkim@inha.ac.kr (H.W. Kim).

0009-2614/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.cplett.2006.02.062

percentage of O_2 and Ar partial pressure, respectively, were set to approximately 3 and 97%. After 2 h of evaporation, the furnace was allowed to cool down to room temperature.

The crystal structure of the products were examined by means of X-ray diffraction (XRD, X'pert MRD-Philips) analysis with Cu $K\alpha_1$ radiation ($\lambda = 0.154056$ nm) and incidence angle of 0.5°. The overview of the sample morphology was checked by scanning electron microscopy (SEM, Hitachi S-4200). Transmission electron microscopy (TEM) was performed by a filed emission electron microscope (Philips CM-200). For the TEM observation, the products were ultrasonically dispersed in acetone, and a drop of the solution was placed on a Cu grid coated with a porous carbon film. PL measurements were carried out by using a He–Cd laser line (325 nm, 55 mW) as the excitation source at room temperature.

3. Results and discussion

Fig. 1a–c shows the SEM images of the Au (3 nm-thick)-coated substrates prior to MgO deposition with the annealing temperature of 300, 500, and 700 °C, respectively. From the SEM images of the sample with the predeposition annealing at a temperature of 700 °C, we observe the relatively wide island-like structures, while we observe the relatively narrow particle-like structures in the pre-annealed samples in the range of 300–500 °C. We reveal that not only the width of Au structures but also the distance between the neighbouring structures in case of 700 °C-annealed sample is larger than those in case of 300–500 °C-annealed samples. The neighbouring Au particle-like structures generated by the predeposition annealing at 300–500 °C are not even completely disconnected. These results are consistent with our previous experiments, in which the Au film on Si(100) surfaces agglomerated and formed the cluster-like Au structures after annealing at a sufficiently high temperature of 600–700 °C [14]. Fig. 1c reveals that the lateral width of island-like structures is in the range of 40–500 nm.

Fig. 2a indicates the XRD spectrum of the final product without a predepostion annealing and Fig. 2b–d indicates the XRD spectra of the final products with the predeposition annealing at 300, 500, and 700 °C, respectively. Miller

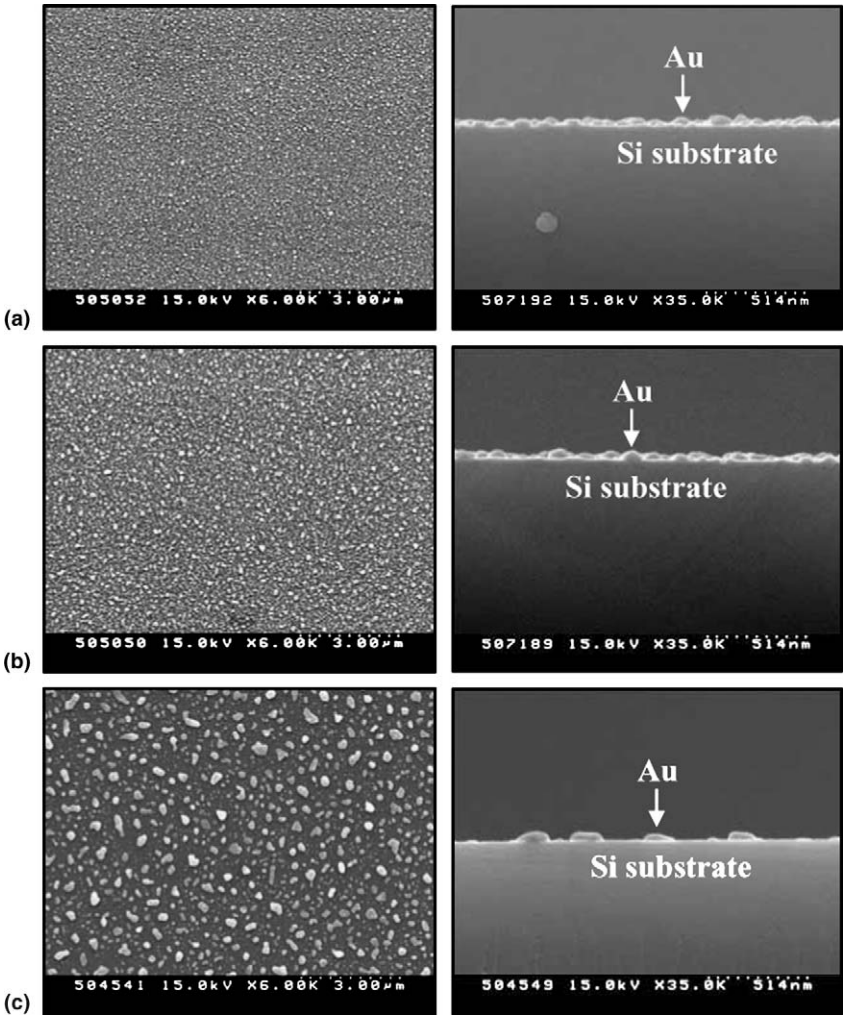

Fig. 1. Top-view and side-view SEM images of the Au (3-nm thick)-coated substrates with the predeposition annealing at: (a) 300, (b) 500, and (c) 700 °C.

Download English Version:

https://daneshyari.com/en/article/5390487

Download Persian Version:

https://daneshyari.com/article/5390487

Daneshyari.com