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Synthesis of one-dimensional SnO_2 nanorods via a hydrothermal technique

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ABSTRACT

We have developed a simple solution process to synthesize tin oxide nanorods. The influence of precursors and the reaction temperature on the morphology of SnO_2 is investigated. SnO_2 nanorods are characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM), and Raman spectroscopy. The as-grown SnO_2 nanorods are uniform in size with a radius of 50–100 nm and length of 1–2 μm. The nanorods grow direction is parallel to the [1 0 1] direction. Possible growth mechanism of SnO_2 nanorods is discussed.

1. Introduction

Controlled synthesis of nanostructures is an important step for the manufacturing of nanodevices. Performance of semiconductor nanodevices may depend on their morphology. Recently, one-dimensional (1D) materials have attracted great interest due to their potential applications as interconnects and functional components [1–5]. 1D oxide nanostructures showed interesting properties, chemical and thermal stability, diverse functionalities, high durability, owing to their high degree of crystallinity [3], and emerge as nanoscale building blocks for electronic and optoelectronic devices [4,5]. At the same time, the interest in developing parts per billion (ppb)-level gas sensors requires new approaches and new nanomaterials. One of the most important sensor materials is tin oxide (SnO_2), which is a low-cost, large-bandgap (3.6 eV, at 300 K), and n-type semiconductor [6]. SnO_2's properties are greatly affected by the size and morphology, which define their further applications. Thus, designing SnO_2 1D nanorods and nanoarchitectures with well-defined morphologies is of importance for fundamental research and high-tech applications.

Fabrication of SnO_2 nanorods has been accomplished using several vapor deposition techniques, such as rapid oxidation [7], chemical vapor deposition (CVD) [8], and thermal evaporation [9]. Peng et al. [10] have recently reported a hydrothermal synthesis of SnO_2 nanorods. However, organic reagents such as hexanol and sodium dodecylsulfate used in the synthesis of SnO_2 nanorods can lead to undesirable impact on human health and on the environment [6]. Zhang et al. [11] also reported a low-temperature fabrication (at 200 °C for 18 h) via a hydrothermal process of crystalline SnO_2 nanorods. Vayssieres et al. [12] reported SnO_2 nanorods arrays grown on F-SnO_2 glass substrates by aqueous thermohydrolysis at 95 °C.

In this work we report a simple, one-step low-temperature aqueous synthesis of SnO_2 1D nanorods without the need of templates or surfactants.

2. Experimental details

The SnO_2 nanorods were synthesized via a hydrothermal method, which is similar to the method used in SnO_2 microcubes

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