Synthesis and characterization of indium oxide and beta-gallium oxide nanowires

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Semiconducting materials with low-dimensional structure have attracted much attention in recent year because of their special properties and potential applications [1]. Since discovery of carbon nanotube in 1991 by Iijima [2], many semiconducting nanowires, such as Si, Ge, GaAs, and GaN, had been successfully synthesized by various methods. However there is only a few reports about oxide system in the literature. In this study, we report the synthesis of In2O3 and b-Ga2O3 nanowires by physical evaporation without metal catalyst. In addition, we investigate the morphology and the structure of the In2O3 and b-Ga2O3 nanowires using scanning electron microscopy (SEM) equiped with energy dispersive spectrometry (EDS), an x-ray diffraction (XRD) with Cu Ka radiation, and transmission electron microcopy (TEM).

To synthesize the nanomaterials of In2O3 and b-Ga2O3, a conventional horizontal tube furnace was used. The reaction temperature was 850-900 oC, and the reaction time was 30 min-4 hr.

Figure 1 shows typical SEM images of the nanowires of In2O3 and b-Ga2O3 synthesizied by physical evaporation. As shown in Fig. 1, we have successfully synthesized the nanowires of In2O3 and b-Ga2O3 without metal catalyst. The nanowires synthesized by our method have uniform morphology and good crystallinity. The XRD data reveal that the In2O3 nanowires are cubic structure with the lattice constant a=1.012 nm and the b-Ga2O3 nanowires are monoclinic structure (a=12.23 nm, b=3.04 nm, c=5.80 nm, b=103.8 o), and their structures are same with bulk materials.

Typical high-resolution TEM (HRTEM) images of the nanowires of In2O3 and b-Ga2O3 are shown in Fig. 2. Fig. 2a shows a HRTEM image of the In2O3 nanowire. The In2O3 nanowire grown along [100] direction have no amorphous layer in surface of the nanowire and no defects. Fig. 2b is a HRTEM image of the b-Ga2O3 nanowire. From the HRTEM

image, it was found that the b-Ga2O3 nanowire grew along nearly parallel direction with (100) plane and has many defects.

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References

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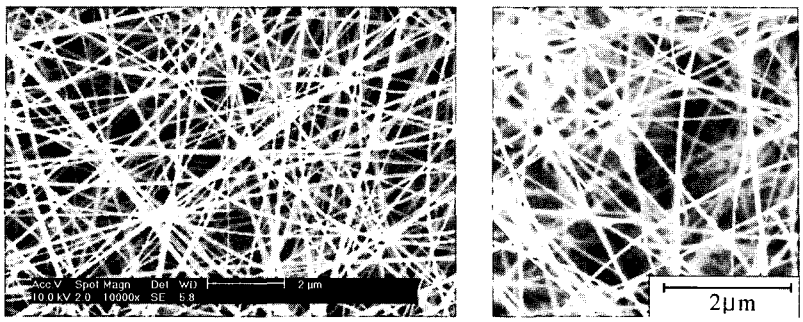

Fig. 1. SEM images of (a) In2O3 and (b) b-Ga2O3 nanowires synthesized by physical evaporation.

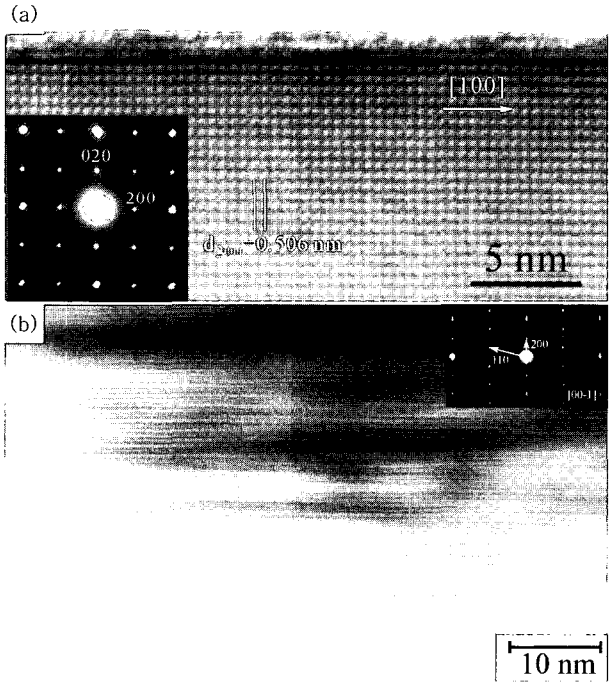

Fig. 2. HRTEM images of the nanowire of (a) In2O3 and (b) Ga2O3 showing growth direction and microstructure. Lower insert of (a) and upper insert of (b) are selected-area diffraction pattern (SADP) of the In2O3 and Ga2O3 nanowire respectively.