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# Electrical Properties and Characterization of the Electrodeposited InSb Semiconductor Nanowires

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A number of research groups have extensively investigated various nanowire arrays fabricated by direct electrodeposition into self-ordered nanoporous anodic aluminum oxide (AAO) mainly due to increasing interest in electrodeposition of metallic/magnetic nanostructures[1-3] and semiconductor nanostructures. In the case of the electrodeposition of compound semiconductor nanostructures, however, only a few studies can be seen because electrodeposition of high quality compound semiconductors from aqueous solutions in the form of films or nanostuctures still presents a challenge. In this article, we report the electrical properties and crystallographic structures of nanowire arrays of III-V compound semiconductor InSb. To the best knowledge, the electrical properties of InSb nanowires have not been reported yet in spite of its good characteristics as a III-V compound semiconductor such as narrow band gap and various applications in Hall effect device, infrared detection, and magneto-resistive sensing.

As a starting material, a pure aluminum foil (99.9 %, Merck) was used, and first anodizing process was conducted in 3 wt % $H_2SO_4$ aqueous solution at 23 V. The temperature of the electrolyte was kept constant at room temperature. After first anodizing for 5 h, the AAO was immersed in an etching solution of 6 wt% $H_3PO_4$ and 1.8 wt% $H_2CrO_4$ at 60 °C for 40 min in order to remove the irregularly anodized layer. Then the aluminum foil was reanodized for 1 hour under the same anodizing conditions for the regularly arranged AAO. Arrays of InSb semiconductor nanowires were fabricated by dc electrodeposition into the nanopores of the AAO. The nanowire arrays were electrodeposited in a mixing solution of indium chloride, antimony chloride, citric acid, and potassium citrate according to our previous work on the electrodeposition of the stoichiometric InSb films. In electrodeposition process, a high purity graphite counter electrode and a silver/silver chloride reference electrode were used. The electrolyte for InSb nanowires was kept at 30±0.1℃. The electrical properties of nanowire arrays were measured by semiconductor parameter analyzer, and the microstructural characterization of the nanowires was conducted by employing TEM and XRD to correlate the electrical properties of InSb nanowires with their crystallographic and microstructural features. Especially, by measuring I-V curves and Hall effects for the films factors affecting the electrical properties of the electrodeposited InSb were investigated.

In this study, the electrical properties of InSb nanowires fabricated by electrodeposition into self-ordered nanopores in AAO were strongly dependent on the stoichiometries and crystalline structures.

Our experimental results indicate that the InSb nanowires have different crystallographic structures and compositions according to the applied current density, and therefore, exhibit different electrical properties.

Reference

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3. K.H.Lee, G.H.Kim, Y.J.Kim, W.Y.Jeung, Mater. Sci. Forum 437-438 (2003) 499.

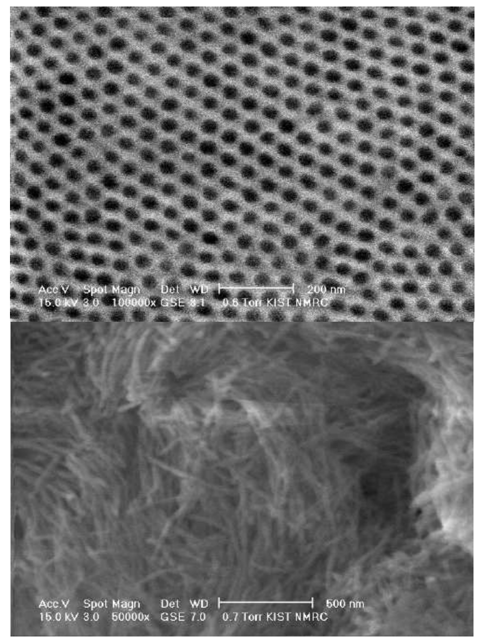


Fig. 1. The ESEM (environmental scanning electron microscopy) images of AAO (a) and InSb nanowires (b) liberated from AAO by dissolving the specimen in 1 M NaOH solution.

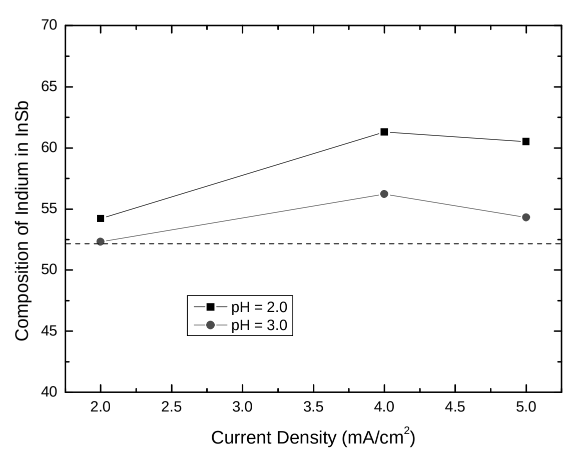


Fig. 2. The variation of the composition of indium in InSb nanowires with current densities.