

Thermodynamic Properties of Bi_2Te_3 Nanowire Arrays

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Bismuth telluride (Bi_2Te_3) is of interest for thermoelectric applications because of the predicted enhancement of the figure-of-merit (ZT) in its nanostructure. We fabricate dense and uniform Bi_2Te_3 nanowire arrays by electrochemical deposition in porous anodic alumina. The morphologies and structure of the nanowires have been characterized using scanning electron microscopy (SEM), X-ray diffraction (XRD), and high-resolution transmission electron microscopy (HRTEM). The characterization of resistivity, the Seebeck coefficient, and the thermal conductivity is critical to validate the figure-of-merit. Measurements of these properties were performed on Bi_2Te_3 nanowire arrays with 20-50 nm diameters. We report the following consequences: 1. The temperature-dependent resistance of the nanowire arrays showed a semiconductive behavior. 2. No enhancement in the Seebeck coefficient on 50 nm p-type Bi_2Te_3 nanowire arrays was observed. 3. The thermal diffusivity was carried out on the nanowires/alumina nanocomposite. The measured values indicated that the thermal conductivity along the axes of Bi_2Te_3 nanowires is reduced from the bulk value. The theoretical calculation has predicted that an obvious enhancement in ZT values will be observed at diameters of nanowires smaller than 20 nm. The measurements performed on the 20 nm array will be reported. Experiments suggest that we may see enhancement of the thermoelectric figure-of-merit if the diameter of the nanowire is small enough.