§10. Thermoelectric Properties Measurement of Bi Nano/Micro Wire Array

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Nanowire structure has been believed to enhance the thermoelectric properties due to introducing quantum effect. Our group has being studied to obtain the bismuth nanowire sample.[1)] New technologies have being developed to get high performance thermoelectric properties. As a first step, a study using wires in the micro-regions called microwire array focused on making the problems do clear from bulk to the micro-region. A serious problem was electrically contact between all wire edges of both side at the microwire array and its electrodes made by metal, and thin film layers were deposited in order to eliminate its contact resistance.[2)] The technique makes it possible to neglect the contact resistance in the micro-region. As a second step, a long template having several milli-meter and a diameter of nano/micro-order size holes made by quartz was successfully fabricated. The bismuth material was injected into the hole of the template by high-pressure-injection method as shown Fig. 1. A nano/micro mixed wire array sample by using temple made by quartz has also been developed. The temperature dependence of the Seebeck coefficient and the resistance were estimated from 50 to 300 K. Although the behavior of the dependence of the Seebeck coefficient is similar to that of bulk, the temperature coefficient of the resistance is much less than that of the bulk sample. The magnetic field dependence of the Seebeck coefficient was also measured. Since the Umkehr effect was observed, and it has showed that the nano/micro mixed wires was a bundle of single crystal ones. The great magnitude of the Seebeck coefficient beyond a classical theory in high magnetic field and low temperature region was measured in Fig.2 , it has implied that the quantization of its Fermi surface happens even if a diameter of the wire does not completely have an order of the nano-region.

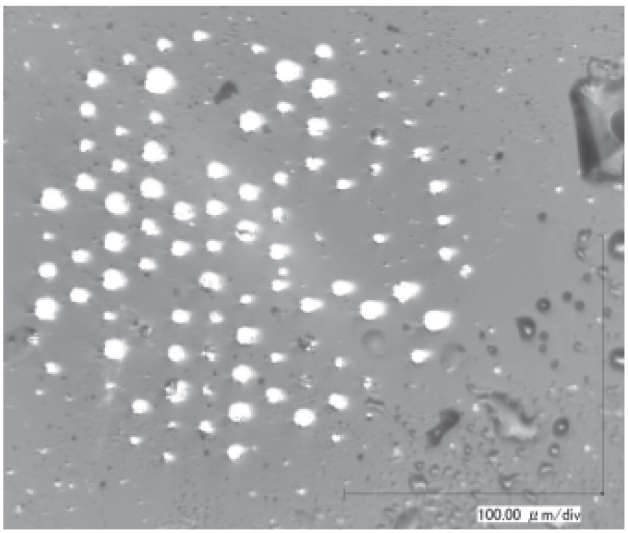

Fig. 1. Cross section image of Bi nano/micro wire array by using microscope.

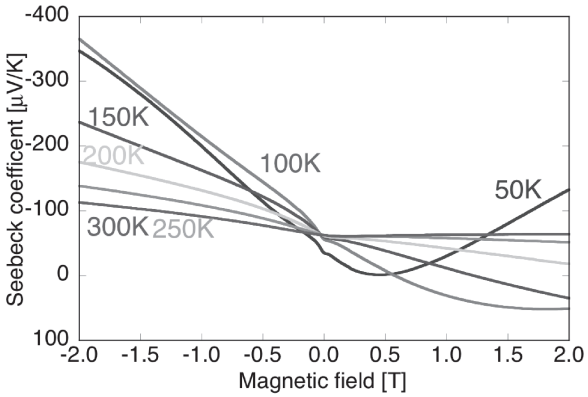

Fig.2. Magnetic field dependence of the Seebeck coefficient.

1) Hasegawa, Y. et al.: J. Appl. Phys. 102 (2007) 073071

2) Hasegawa, Y. et al.: Rev.Sci. Inst. 76 (2005) 113902