Thermal conductivity of individual single-crystalline Bi nanowires grown by stress-induced recrystallization

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Abstract : It has been challenging to increase the thermoelectric figure of merit ($ZT=S^2\sigma T/\kappa$) of materials, which determine the efficiency of thermoelectric devices, because the three parameters Seebeck coefficient (S), electrical conductivity (σ), and thermal conductivity (κ) of bulk materials are inter-dependent. With the development of nanotechnology, ZT values of nanostructured materials are predicted to be enhanced by classical size effects and quantum confinement effects. In particular, Bi nanowires were suggested as one of ideal thermoelectric materials due to the expected quantum confinement effects for the simultaneous increase in S and . In this work, we have investigated the thermal conductivity of individual single crystalline Bi nanowires with d = 98 nm and d = 327 nm in the temperature range 40 - 300 K using MEMS devices. The for the Bi nanowire with d = 98 nm was observed to be ~ 1.6 W/m-K at 300 K, which is much lower than that of Bi bulk (8 W/m-K at 300 K). This indicates that the thermal conductivity of the Bi suppressed due to enhanced surface boundary scattering in one-dimensional structures. Our results suggest that Bi nanowires grown by stress-induced method can be used for high-efficiency thermoelectric devices.

key words : Bi nanowire, Thermal conductivity, Surface boundary scattering