Thermoelectric properties of individual PbTe nanowires grown by a vapor transport method

Seunghyun LEE,[1] Soyoung Jang,[2] Jun Min Lee,[1] Jong Wook Roh,[1] Jeunghee Park,[2] and Wooyoung LEE[1,*]

[1] *Nanomedical National Core Research Center and Department of Materials Science and Engineering, Yonsei University, 134 Shinchon, Seoul 120-749, Korea*

[2] *Department of Chemistry, Korea University, Jochiwon, Chungnam 339-700, Korea*

Abstract : Lead telluride (PbTe) is a very promising thermoelectric material due to its narrow band gap (0.31 eV at 300 K), face-centered cubic structure and large average excitonic Bohr radius (46 nm) allowing for strong quantum confinement within a large range of size. In this work, we present the thermoelectric properties of individual single-crystalline PbTe nanowires grown by a vapor transport method. A combination of electron beam lithography and a lift-off process was utilized to fabricate inner micron-scaled Cr (5 nm)/Au (130 nm) electrodes of Rn (resistance of a near electrode), Rf (resistance of a far electrode) and a microheater connecting a PbTe nanowire on the grid of points. A plasma etching system was used to remove an oxide layer from the outer surface of the nanowires before the deposition of inner electrodes. The carrier concentration of the nanowire was estimated to be as high as 3.5×10^{19} cm^{-3}. The Seebeck coefficient of an individual PbTe nanowire with a radius of 68 nm was measured to be $S = -72$ μV/K at room temperature, which is about three times that of bulk PbTe at the same carrier concentration. Our results suggest that PbTe nanowires can be used for high-efficiency thermoelectric devices.

key words : PbTe nanowire, Seebeck coefficient, Carrier concentration, Mott relation