**Thermal and thermoelectric transport properties of an individual boron arsenide microstructure by a novel four-probe thermal measurement method**

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Abstract

Several experimental techniques reported in recent years have enabled the measurement of thermal transport properties of nanostructures. However, eliminating the contact thermal resistance error from the measurement results has remained a critical challenge. To overcome this issue, we developed a novel four-probe measurement method that can separately obtain both the intrinsic thermal conductance and the contact thermal resistance of individual nanostructures. The measurement device consists of four microfabricated, suspended metal lines that act as resistive heaters and thermometers, across which the nanostructure sample is assembled. The method takes advantage of the variation in the heat flow along the suspended nanostructure and across its contacts to the four suspended heater and thermometer lines, and uses sixteen sets of temperature and heat flow measurements to obtain nine of the thermal resistances in the measurement device and the nanostructure sample, including the intrinsic thermal resistance and the two contact thermal resistances to the middle suspended segment of the nanostructure.

This novel method was applied to an individual boron arsenide (BAs) microstructure, which is predicted to have an unexpectedly high thermal conductivity by recent first principles calculation. The measured thermal conductivity was found to decrease slightly with temperature in the range between 250 K and 350 K. The room temperature value of (186 ± 46) W m−1 K−1 is higher than that of bulk silicon but still a factor of four lower than the calculated result for a defect-free, non-degenerate BAs rod with a similar diameter of 1.15 μm. The measured p-type Seebeck coefficient and thermoelectric power factor are comparable to those of bismuth telluride, which is a commonly used thermoelectric material. The foregoing results also suggest that it is necessary to not only reduce defect and boundary scatterings but also to better understand and control the electron scattering of phonons in order to achieve the predicted ultrahigh intrinsic lattice thermal conductivity of BAs.