Thermoelectric Properties of Nanowires & Nanotubes Used for Energy Conversion

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Abstract:

Although the thermal properties of nanowires and nanotubes can differ greatly from their bulk counterparts, the theoretical and experimental understanding of these differences is still limited. Thermal performance is especially important for nanowire thermoelectrics, which are expected to have energy conversion efficiencies far superior to bulk materials. This efficiency increase may lead to a broad range of applications for reliable, solid-state energy conversion, including waste heat scavenging and household refrigeration.

Here we first describe models that use both classical (particle) and quantum (wave) size effects to explain the altered thermal properties of nanowires and nanotubes. These models are generally in good agreement with available experimental data. However, measurements at the single-wire level are challenging and tend to lack detailed information about the atomic-level structure of the sample and contacts. We have modified a high-resolution transmission electron microscope (HRTEM) with integrated scanning tunneling microscope (STM) for in-situ thermoelectric measurements. A custom-built thermoelectric probe is installed inside the TEM and can measure the electrical conductivity, thermal conductivity, and Seebeck coefficient of individual nanowires and nanotubes.