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Toward quantum confinement in Bi-based thermoelectric materials

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The potential for nanowires and quantum wells to improve thermoelectric (TE) performance via quantum confinement has been theorized since 1993, with proposed $ZT > 10$ for 0.5 nm diameter Bi_2Te_3 wires[1]. However, such dimensionality is nearly impossible to grow; all Bi-based nanowire studies report *ZT's* below bulk values. Indeed, reports with $ZT \geq 1$ from thin film superlattices[2] and nanostructured bulk materials[3] were achieved via phonon engineering, not quantum confinement.

Reviewing the Bi-based nanowire literature reveals that crystalline quality, and therefore electron transport, has been greatly ignored. Hence, we studied growing high-crystalline quality Bi, Bi_2Te_3, and Bi_xSb_{1-x} nanowires[4-6]. However, measuring transport properties from Bi-based nanowires is challenging: reports are few and our efforts were inconclusive. I will discuss the importance of nanowire crystallization and the difficulties making electrical and thermal contacts.

We are now approaching quantum confinement in a novel manner starting with high-crystalline quality thin films of a single-phase Bi-based material. I will report on the correlation of TE properties with structural quality, which we believe to be the starting point for creating the nanoscale dimensionality critical to observing quantum confinement via post-growth fabrication processes.

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