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IAPME Seminar

Decouple electron and phonon transport for high-performance thermoelectrics

20 November 2024

Prof. Jiaqing HE
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Venue: N23-4018
Time: 15:00 - 16:00
Hosted by: Prof. Haifeng LI

Abstract

Thermoelectrics enable direct heat-to-electricity transformation, but their performance has so far been restricted by the closely coupled electron and phonon transport. The figure of merit, *ZT*, is the essential measure of thermoelectric performance and can be calculated by $ZT = S^2\sigma T/\kappa$, where *S*, σ, κ, and *T* are Seebeck coefficient, electrical conductivity, total thermal conductivity and absolute temperature, respectively. Although established strategies to optimize *ZT* usually treat electrical and thermal properties separately, enhancing *ZT* requires simultaneous optimization of the adversely interdependent *S*, σ, and κ, which is challenging because most crystal imperfections are believed to scatter both phonons and electrons. This presentation will show that the power factor ($S^2\sigma$) can be boosted by trap hole release and energy-band engineering including band convergence. The total thermal conductivity can be suppressed by the introduction of all scale defects, high entropy, quantum gap and so on, which provide general methods for boosting their thermoelectric performance. It will also illustrate three examples（PbQ, GeTe, and $AgCrSe_2$）of emerging excitements in nanostructured materials and systems for thermoelectric materials. It will highlight the role of advanced and classical electron microscopy in unravelling the hierarchical architecture of the constituents and their intimate interplay in governing key phenomena in thermoelectric materials.

Biography

Prof. Jiaqing HE is a Chair Professor in the Department of Physics at Southern University of Science and Technology and the Director of the Research Department. He is also a Fellow of the American Physical Society. He obtained his Bachelor's degree in Physics from Wuhan University in 1998 and his Ph.D. in Physics from a joint program between Wuhan University and the Jülich Research Centre in Germany in 2004. From 2004 to 2012, he worked at Brookhaven National Laboratory and Northwestern University in the United States. His primary research focuses on transmission electron microscopy, thermoelectric materials, and the correlation between structure and properties. He has published over 300 high-impact SCI journal papers, including eight in Science and three in Nature, with nearly 40,000 citations and an H-index of 93. He has applied for 52 domestic and international patents, of which 32 have been granted.

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