MATERIALS SCIENCE AND ENGINEERING (MS&E) SEMINAR SERIES
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Entropy engineering of SnTe towards high-entropy thermoelectrics

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Biography: Dr. Jian He is an associate professor in the Department of Physics and Astronomy at Clemson University, where he has been a faculty member since 2008. He completed his Ph.D. at the University of Tennessee, Knoxville and his undergraduate studies at Jilin University, China, both in condensed matter physics. His research interests lie in several subareas of condensed matter physics and materials science: single crystal growth of oxides and intermetallic compounds, novel materials synthesis techniques, electrical, thermal, magnetic characterization, and also thermoelectric materials research. He has authored or co-authored over 160 peer reviewed publications with a H-index of 41 and presented over 30 invited talks. He is a member of the Science magazine's Board of Reviewing Editors.

Abstract: High entropy thermoelectrics is a synergy of thermoelectric materials research and high entropy alloying. Thermoelectrics is the simplest technology applicable to direct heat-to-electricity energy conversion, while high entropy alloying is a conceptual breakthrough in materials synthesis that drastically extends the phase space and elicits exceptional material properties. In this presentation, I shall briefly review the role of entropy in general thermoelectric process, and then discuss a case study in SnTe in light of the core effects of high entropy alloys. Upon entropy engineering, the solubility of Mn is extended in favor of band gap enlargement and band convergence, which compensate the degraded carrier mobility; the scattering mechanism of charge carrier crossovers from electron-phonon scattering to alloying scattering; despite a simple face centered cubic structure, the lattice thermal conductivity is lowered to a level comparable to the amorphous limit due to multi-scale hierarchical microstructures and severe lattice distortion. A state-of-the-art figure of merit ~ 1.42 is attained in $(Sn_{0.74}Ge_{0.2}Pb_{0.1})_{0.75}Mn_{0.275}Te$ at 900 K. These results attest to the efficacy of entropy engineering in thermoelectric materials research and also a caveat: the configurational entropy should be high enough to elicit the core effects of high entropy alloys yet low enough to minimize the degradation of carrier mobility.

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