工学系WINGS産学協創教育推進基金

第408回GMSI公開セミナー／第153回WINGSセミナー

Strategies for Engineering Complex Thermoelectric Materials

Professor G. Jeffrey Snyder

Northwestern University

Date： Friday, December 1, 2023 15:00-16:00

Venue：Faculty of Engineering Bldg. 2, Room 31A

Abstract:

Thermoelectric (TE) energy conversion is widely studied for its potential to produce electricity from waste heat [NM2008] or provide cooling without the use of harmful refrigerants[Joule]. There are a number of common strategies used to engineer higher thermoelectric figure of merit, zT, in complex materials. Because the properties that make up zT are all interrelated, the improvement of thermoelectric materials is best guided by the thermoelectric Quality Factor B, proportional to the weighted mobility, μ_W, and lattice thermal conductivity, κ_L, as $B \sim \mu_W/\kappa_L$. The weighted mobility is a better measure of the relevant electronic properties than the power factor because it is a constant material property. Strategies to reduce κ_L, must not significantly reduce μ_W for there to be a net improvement in B and therefore zT.

The weighted mobility, μ_W, is related to the mobility measured by the Hall effect and density of electronic states measured by the Seebeck effective mass m^*. This can be used to identify high effective band degeneracy and band convergence which is known to lead to high B and zT with examples of $zT > 1$ found in PbTe, GeTe, and Mg_3Sb_2.

In this context, we review the strategies of energy filtering with grain boundaries, band engineering with topological band structures, and *phase boundary mapping* to engineer dopants and avoiding excessive *grain boundary electrical resistance*. Finally the method to easily calculate device ZT will be introduced to accurately compare the maximum efficiency of a new material with others in a thermoelectric device.

Professor G. Jeffrey Snyder
Northwestern University

Biography:

G. Jeffrey Snyder is a Professor of Materials Science and Engineering at Northwestern University. His interests are focused on engineering of electronic and thermal properties and he is well known for his work on thermoelectric materials. He has developed new methods of electron band structure engineering and microstructure engineering of thermal and electrical properties of complex materials. His interdisciplinary approach stems from his background in Solid State Chemistry at Cornell University and the Max Planck Institute for solid state research, Applied Physics at Stanford University and thermoelectric materials & device engineering at NASA/Jet Propulsion Laboratory and California Institute of Technology (Caltech).

主催： 東京大学大学院工学系研究科専攻間横断型教育プログラム 機械システム・イノベーション（GMSI）
未来社会協創国際卓越大学院（WINGS CFS）
量子科学技術国際卓越大学院（WINGS-QSTEP）
統合物質・科学国際卓越大学院（MERIT-WINGS）
高齢社会総合研究国際卓越大学院（WINGS-GLAFS）
工学系WINGS産学協創教育推進基金

本件連絡先： 東京大学大学院工学系研究科総合研究機構　教授　塩見　淳一郎
GMSI事務局　E-mail: office@gmsi.t.u-tokyo.ac.jp　Phone: 03-5841-0696