UCF | Materials Science and Engineering

UNIVERSITY OF CENTRAL FLORIDA

MATERIALS SCIENCE & ENGINEERING DISTINGUISHED SEMINAR SERIES

Donald Morelli, Ph.D.

Professor and Chair

Department of Chemical Engineering Materials Science

Michigan State University

Friday

November 1, 2019

11:00AM — 12:00PM

HEC

Room 101

Contact: Dr. Tengfei Jiang

Materials Science & Engineering

Phone: 407-823-2284

Email: Tengfei.Jiang@ucf.edu

Rapid Synthesis and Processing of Tetrahedrite-Based Thermoelectrics with Intrinsically Minimal Thermal Conductivity

In order to function efficiently, thermoelectric materials require a unique combination of thermal and electronic transport properties. One important design criterion, for example, is to minimize thermal conductivity, and one successful approach to achieving this condition is the concept of phonon-glass-electron-crystal (PGEC), in which localized phonon modes of guest atoms in cage-like structures, such as skutterudites and clathrates, induce strong phonon scattering. Using the family of tetrahedrite-based semiconductors as an example, we show that PGEC-like behavior can manifest itself in crystals that possess no noticeable cage-like structure. We will first present an overview of several approaches for rapid synthesis of tetrahedrite which yield material with thermoelectric figure of merit comparable to that obtained using conventional solid-state synthesis. Using a combination of theoretical calculations, x-ray and neutron probes, and thermal and electronic characterization, we show that this PGEC-like behavior in tetrahedrites has its origin in a unique set of structural and bonding aspects that give rise to strong lattice anharmonicity and low lattice thermal conductivity. This low thermal conductivity, in concert with a favorable band structure, endows tetrahedrite with a thermoelectric figure of merit rivalling that of PbTe. Because tetrahedrite contains no toxic or rare elements, it is a strong competitor as a low cost, environmentally benign material for thermoelectric power generators.

Biography: **Donald Morelli** is currently Professor in the Department of Chemical Engineering Materials Science at Michigan State University, and has served in the capacity of Department Chairperson since 2015. From 2009-2016 he served as Director of the MSU/DOE Energy Frontier Research Center on Revolutionary Materials for Solid State Energy Conversion (RMSSEC). Prior to joining MSU in 2007, he spent 21 years in industry, first at General Motors Research Laboratories as a Senior Research Scientist, before moving to Delphi Corporation Research Labs in 1999, where he was Staff Research Scientist and Group Leader of the nanomaterials group. His research has spanned a variety of topics, including: semimetals, conducting polymers, high temperature superconductors, wide and narrow band gap semiconductors, high thermal conductivity crystals, thermoelectric materials, and magnetism. He has published over 160 scientific papers, coauthored six book chapters, and received 23 U.S. patents. Dr. Morelli holds BS and PhD degrees in physics from the University of Michigan.