

Dean's Colloquium

Dr. Kai Zhang

Department of Physics



When: Wednesday, March 20, 2024

Where: Turner 129

Time: 3:00-3:20 pm, Q&A: 5 min

Title: Novel Approach to Achieve High ZT Thermoelectric Materials

Abstract: High efficiency thermoelectric materials have attracted considerable attention because of their application potential in power generation and refrigeration systems. The efficiency of thermoelectric materials is expressed by the figure of merit. It is observed that higher thermoelectric efficiency can be obtained by increasing the electron conductivity and reducing thermal conductivity. A decrease of thermal conductivity could be achieved by a low dimensional superlattice structure, due to the quantum confinement or phonon scattering. lead chalcogenides such as PbTe and PbSe alloys have a high figure of merit and work best for thermoelectric devices used for the temperature range 400 to 900 K. Here we review advances in the ALD synthesis of composite thermoelectric nanolaminates of PbSe and PbTe films. Extensive physical and electrical characterizations were performed to elucidate the ALD nanolaminate growth mechanism. Nanolaminate structure of alternating ALD PbTe and PbSe layers exhibiting localized epitaxial growth within individual islands as revealed by high resolution TEM cross-section analysis, because of the similar lattice constants between the PbTe and PbSe ALD layers. We discuss various approaches to enhance the figure of merit ZT and the Seebeck coefficient for ALD PbTe & PbSe films employing nanolaminates, which introduce a large density of interfaces to enhance phonon scattering resulting in an effective reduction of the thermal conductivity, and a concurrent significant improvement of ZT.

Biography: Dr. Zhang joined the Department of Physics at HU in September 2023. Dr. Zhang received a Ph. D. Degree from Norfolk State University. Dr. Zhang worked as a Research Scientist at Old Dominion University and ODU-Applied Research Center at JLab. Dr. Zhang has held DRAM and Emerging Memory Quality and Reliability Assurance (DEMORA) process engineer at Micron Technology headquartered in Boise, Idaho. Dr. Zhang's research interest focus on semiconductor nanostructure and nanomaterials, thermoelectric materials, bio-nanoparticles and transparent ceramics. Dr. Zhang has published 43 refereed journal papers in prestigious peer-reviewed engineering and scientific journals, and 23 conference proceedings at international conferences.