Michigan State University

Science at the Edge

Engineering Seminar

November 16, 2018
11:30 a.m., Room 1400 Biomedical and Physical Sciences Building
Refreshments served at 11:15 a.m.

David G. Cahill

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Extremes of Heat Conduction: Searching for the Perfect Thermal Insulator

Abstract

Thermal conductivity is a basic and familiar property of materials: silver spoons conduct heat well and plastic does not. In recent years, the combined efforts of materials scientists, engineers, physicists, and chemists have succeeded in pushing-back long-established limits in the thermal conductivity of materials. Our measurements of heat conduction in novel materials are enabled by ultrafast optical pump-probe metrology tools, e.g., time-domain thermoreflectance (TDTR). At the high end of the thermal conductivity spectrum, theory and experiment recently revealed unexpectedly high thermal conductivity in the binary compound BAs with a thermal conductivity higher than any material except diamond and graphite. At the low end of the thermal conductivity spectrum, solids that combine order and disorder in the random stacking of two-dimensional crystalline sheets, so-called "disordered layered crystals" show a thermal conductivity only a factor of 2 larger than air; similarly low thermal conductivity is exhibited by functionalized C60 buckyballs assembled into dense thin films. Extremes of high pressures (up to 60 GPa in diamond anvil cells) allow us to continuous change the strength of molecular interactions in glassy polymers and test models for heat conduction that originate with the 1911 theory of Einstein.

Bio

David Cahill is the Willett Professor and Department Head of Materials Science and Engineering at the University of Illinois at Urbana-Champaign. He joined the faculty of the U. Illinois after earning his Ph.D. in condensed matter physics from Cornell University, and working as a postdoctoral research associate at the IBM Watson Research Center. His research program focuses on developing a microscopic understanding of thermal transport at the nanoscale; the discovery of materials with enhanced thermal function; the interactions between phonons, electrons, photons, and spin; and advancing fundamental understanding of interfaces between materials and water. He received the 2018 Innovation in Materials Characterization Award of the Materials Research Society (MRS); the 2015 Touloukian Award of the American Society of Mechanical Engineers; the Peter Mark Memorial Award of the American Vacuum Society (AVS); and is a fellow of the MRS, AVS, and APS (American Physical Society).

For further information, please contact Prof. Alexandra Zevalkink, Department of Chemical Engineering and Materials Science at alexzev@egr.msu.edu.

Persons with disabilities have the right to request and receive reasonable accommodation. Please call the Department of Chemical Engineering and Materials Science at 355-5135 at least one day prior to the seminar; requests received after this date will be met when possible.