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」

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第228回GMSI公開セミナー／第52回CIAiSセミナー

Recent Progresses in Nanoscale Thermal Transport Measurements of Emerging Materials

Professor Li Shi

BF Goodrich Endowed Professor in Materials Engineering,
Department of Mechanical Engineering and Texas Materials Institute, The University of Texas at Austin

日 時: 2017年3月15日(水) 14:00－15:30
場 所: 東京大学工学部2号館 3F 232講義室

Although the electrical transport property can range widely from superconducting to perfectly insulating in different materials, their thermal transport properties are confined in a relatively small range, which limits the performance of electronic, optoelectronic, and thermoelectric devices. Recently, we have carried out fundamental studies of the transport and coupling of thermal energy carriers including electrons, phonons, and magnons in different materials in order to search for new approaches to achieving extraordinary thermal properties. Highly sensitive micro-fabricated devices are invented to probe size-dependent phonon transport in one-dimensional and two-dimensional hexagonal structures as well as three-dimensional cubic boron arsenide with potentially record high thermal conductivity. Inelastic neutron scattering is employed to understand the intriguing phonon and magnon dynamics of complex incommensurate crystals with low lattice thermal conductivity or high magnon thermal conductivity. Inelastic light scattering experiments are further designed to probe the remarkably long relaxation lengths of phonons and magnons in some hexagonal and magnetic materials, respectively. The findings from these basics studies are used to guide the search of materials with ultrahigh or ultralow thermal conductivity, increased thermoelectric figure of merit, or enhanced spin caloritronic properties.

主催: 東京大学大学院工学系研究科「機械システム・イノベーション」プログラム（GMSI）
「最先端融合科学イノベーション教育研究コンソーシアム」（CIAiS）

本件連絡先: 東京大学大学院工学系研究科機械工学専攻 教授 丸山 茂夫
GMSIプログラム事務局 E-mail: office@gmsi.t.u-tokyo.ac.jp Phone: 03-5841-0696