Research topics for graduate students for 2025

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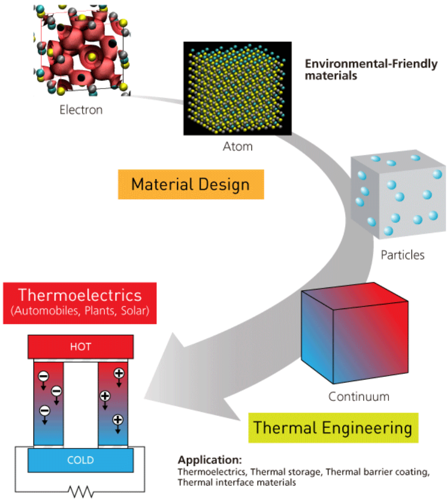
Acceptable course(s)

- Master's Degree
- Doctoral Degree

Research Topics

We study thermal energy transport, storage, and conversion from multiscale viewpoint, ranging from molecular to continuum scales. By exploring new physics and designing new materials, we seek for ways to recycle or handle waste heat energy, which is a key issue to realize sustainable energy and society. Followings are a few research topics.



1. Nanoscale thermal (phonon) engineering

By building structures smaller than characteristic length scale of heat carriers like phonons, we manipulate heat transfer to a great extent. This "phonon engineering" leads to innovation in thermal conductors/insulators and thermoelectrics.

2. Materials Informatics (MI) for heat transfer

How do we develop the best nano/micro-structure to realize preferred heat transfer (conduction, convection, and radiation)? The problem is that the search space is so massive, but we overcome it by combining thermal engineering and machine learning. The optimization process is further accelerated by quantum computation.

3. Controlling dynamic wetting

Understanding and controlling dynamic wetting (e.g. spreading, sliding) of liquid on solid surface is important in boiling, condensation, evaporation, and freezing. We largely manipulate such dynamic wetting phenomena by modifying the interface via chemical functionalization, physical micro-structuring, and/or external forces.

Articles Related to Research Topics

[1] B. Xu, et al, Weaker bonding can give larger thermal conductance at highly mismatched interfaces, *Science Advances* **7**, eabf8197 (2021). [DOI: 10.1126/sciadv.abf8197]; N. Tambo, et al, Ultimate suppression of thermal transport in amorphous silicon nitride by phononic nanostructure, *Science Advances* **6**, eabc0075 (2020) [DOI: 10.1126/sciadv.abc0075]

[2] R. Hu, et al, Machine-learning-optimized aperiodic superlattice minimizes coherent phonon heat conduction, Physical Review X **10**, 021050 (2020) [DOI: 10.1103/PhysRevX.10.021050].

[3] Y. Lee, etal, Vibration sorting of small droplets on hydrophilic surface by asymmetric contact-line friction, *PNAS Nexus* **1**, pgac027 (2022) [DOI: 10.1093/pnasnexus/pgac027].

Lab. Web page: http://www.phonon.t.u-tokyo.ac.jp/?lang=en