ME Seminar

MECHANICAL ENGINEERING
INDIAN INSTITUTE OF SCIENCE

Thermal Innovation for Future Chips

Dr. Bai Song, Peking University, Beijing, China

ABSTRACT

The ever-shrinking dimensions of materials, devices, and systems demand a deeper understanding of the fundamental physics governing heat transport and energy conversion. Meanwhile, as our ability to see, simulate, design, measure, and manipulate matter at small spatial and temporal scales continues to evolve, the rich dynamics of various heat carriers offers unprecedented opportunities for understanding, controlling, and utilizing heat. In particular, phonon band engineering and isotope engineering have recently enabled the demonstration of record-high thermal conductivities in single crystals of cubic boron arsenide and boron nitride, respectively, which is essential for the passive cooling of future chips with an ever-increasing power density. In addition, the engineering of polymer chains has led to orders-of-magnitude enhancement of heat transport in plastics, which may help cool flexible and wearable electronics. My talk will focus on the performance of and the physics behind these emerging materials, and conclude with a brief outlook into the future.

ABOUT THE SPEAKER

Dr. Bai Song is an assistant professor at Peking University (PKU), with joint appointments in the Department of Energy and Resources Engineering, and the Department of Advanced Manufacturing and Robotics. Prior to PKU, he worked as a postdoctoral associate in the Department of Mechanical Engineering at the Massachusetts Institute of Technology. He earned his PhD at the University of Michigan, Ann Arbor, and his ME and BE at Tsinghua University, Beijing. Dr. Song explores at the intersections of thermal science, nanotechnology, and ultrafast physics. His recent projects focus on the mechanisms and limits of heat transport, including near-field thermal radiation at the nanoscale, phonon bandgap engineering and boron arsenide crystals with unusual high thermal conductivity, isotope engineering and record-high thermal conductivity in cubic boron nitride crystals, phonon hydrodynamics and second sound in graphite at elevated temperatures, and heat-conducting plastics. Key breakthroughs have been accomplished in fundamental theories, experimental platforms, and advanced materials, with potentials for enabling a variety of novel applications. Dr. Song is supported by the Overseas High-Level Young Talent Recruitment Program, and a recipient of the 2020 XPLORER PRIZE in Advanced Interdisciplinary Studies.

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