"BNC Seminar"

Friday, July 8th, 2016 @ 11:00am
BRK, ROOM 1001

Yee Kan Koh
National University of Singapore

Title: Graphene for Thermoelectrics? Tailoring Electronic and Phononic Heat Transport Across Graphene Interfaces and Heterostructures

Bio: Yee Kan Koh received a B.S. and a M.Eng. in Mechanical Engineering from the University of Technology Malaysia. In 2004, he enrolled in the University of Illinois at Urbana-Champaign, and obtained a M.S. in Physics in 2007 and a Ph.D. in Materials Science and Engineering in 2010 from the university. After his graduation in 2010, Koh joined the Department of Mechanical Engineering in National University of Singapore (NUS) as an assistant professor. Koh's expertise is in heat transport in nanostructures and across interfaces, with emphasis on applications in thermoelectric energy conversion and thermal management of emerging electronic devices (e.g., graphene devices). Koh is an expert in time-domain thermoreflectance (TDTR), a modulated pump-probe technique to measure heat conduction on nanometer length scales. He has received numerous awards, including the NUS Young Investigator Award (2011), the SMF-NUS Research Horizons Award (2010) and the Ross J. Martin award (2010).

Abstract: Due to the high Debye temperature of graphene, low-energy phonon modes, which carry most heat in e.g., metals, are relative scarce in graphene. Due to the disparity in the energy of phonons in graphene and many common materials, graphene interfaces have relatively low thermal conductance and thus graphene heterostructures with supposedly low thermal conductivity could be explored for possible thermoelectric applications. However, to be an efficient thermoelectric material, substantial amount of heat must be carried by electrons, which do not play an active role in all graphene interfaces studied so far. In this presentation, I focus on presenting our recent results in understanding and tailoring both electronic and phononic heat transport across graphene interfaces. I will start by comparing the thermal conductance of Al/graphene/Cu interfaces, for both as-grown and transferred graphene. We found that interfaces of transferred graphene could be ~35% lower than that of the as-grown graphene, because graphene might not conform fully to the substrate. I will then discuss our efforts to determine the role of remote interfacial phonons (RIP) scattering in heat transport across graphene/SiO_2 interfaces. We developed a voltage-modulated thermoreflectance (VMTR) approach to accurately measure the change of thermal conductance under electrostatic fields, and thus established an upper limit for the contribution of heat conduction by RIP scattering of <2%. Lastly, I will discuss our recent efforts to enhance the electronic heat transport across graphene/metal interfaces. With this capability, we successfully built metal/graphene heterostructures with ultralow thermal conductivity of <0.1 W/m-K, and at the same time, with a ratio of electronic to phononic heat transport of ~1. This interesting graphene heterostructure can thus be explored for thermoelectric applications.