Thermal Transport in Layered Materials and At Their Interfaces

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Understanding thermal transport properties of materials is essential for both device applications and materials physics. Thermal conductivity and interfacial thermal conductance are important engineering parameters for thermal management of small-scale electronics. Moreover, they are difficult to predict or control as heat transport mechanisms may change at the nanoscale. In this talk, I will present how phonon heat transport occurs in layered materials, such as graphite fluoride and transition metal chalcogenides, and at their interfaces. The layered materials are interesting in that they present both extremes of heat transport. The ultrahigh thermal conductivity is observed for the in-plane direction of graphite and graphite fluoride, while the ultralow thermal conductivity is observed along the through-plane direction of ReS2 and WTe2 in 1T’ disordered phase. This also leads to ultralow thermal conductance at the interface between the layered materials and metals, which can be rather utilized for ultrathin thermal insulators. I will also introduce my methodology based on ultrafast pulsed laser source, time-domain thermoreflectance (TDTR), which can effectively investigate the three-dimensional heat transport properties of solids.