Thermal Transport of vdW materials under compressive strain

Yaguo Wang[1]

[1]Department of Mechanical Engineering, University of Texas at Austin, USA

Van der Waals (vdW) materials exhibit highly anisotropic thermal transport, governed by weak interlayer interactions that are readily tunable by external pressure. Using picosecond transient thermoreflectance (ps-TTR) in diamond anvil cells, we investigated the pressure-dependent thermal conductivity of MoS_2, ReS_2, and graphite. In MoS_2, cross-plane thermal conductivity increases nearly sevenfold under 20 GPa due to pressure-enhanced interlayer coupling and phonon hardening. In contrast, ReS_2, which possesses the weakest vdW bonding among transition-metal dichalcogenides, displays strongly anomalous thermal behavior: its cross-plane conductivity oscillates with pressure, reflecting competition between interlayer distance reduction and pressure-induced layer sliding. Graphite shows a monotonic increase in conductivity with compression, consistent with strengthened interlayer coupling and modified phonon dispersions. Together, these results reveal how compressive strain can both enhance and destabilize heat transport in layered solids, highlighting the critical role of interlayer coupling strength and stacking order in governing phonon transport across vdW interfaces.