Surface phonon-polaritons conduction and radiation

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Recent studies indicated that surface phonon-polaritons (SPhPs), which are the evanescent electromagnetic waves generated by the hybridation of the optical phonons and the photons and propagating at the surface of a polar dielectric material surface [1] [2], may potentially serve as novel heat carriers to enhance the thermal performance in micro- and nanoscale devices. We measured thermal conductivities (TCs) of SiN films to study the contribution of SPhPs to heat transfer [3].

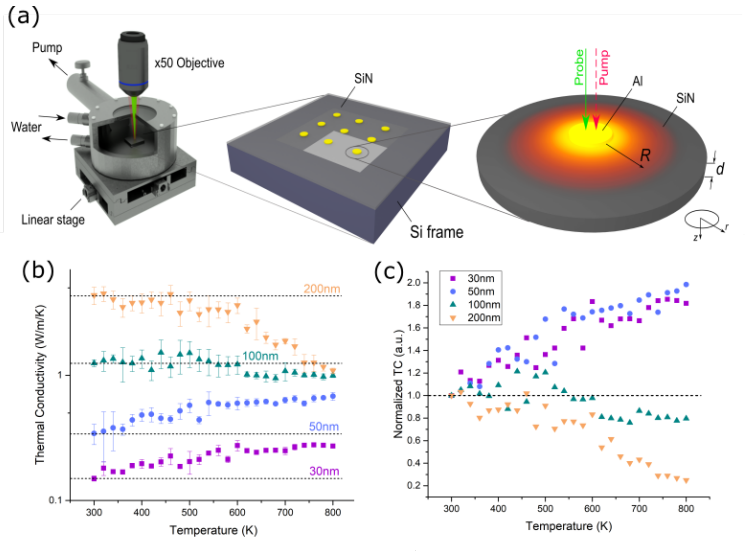

Fig. 1: (a) Schematic of a heating stage and a sample, (b) thermal conductivity as a function of temperature with different thicknesses, (c) thermal conductivities normalized by the one at room temperature, revealing the SPhPs contribution in thinner samples

Figure 1 shows the TCs of SiN films with different thicknesses measured between 300 and 800K. Strong TC enhancement exists at high temperatures by decreasing the film thickness, as expected from the contribution of the SPhPs. Meanwhile for thicker films, TC decreases above 600K and is inversely proportional to temperature, presumably due to the Umklapp scattering and smaller SPhPs contribution.

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References

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