# Experimental Investigation of Size Dependence of Surface Phonon Polaritons Heat Flux

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Thermal conduction becomes less efficient as structures scale down into submicron sizes since phonon-boundary scattering becomes predominant and impede phonons more efficiently than Umklapp scattering. Recent studies indicated that the 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, potentially serve as novel heat carriers to enhance the thermal performance in micro- and nanoscale devices. We conduct a micro time-domain thermoreflectance (μTDTR) measurement of SiN suspended submicron films to study the contribution of SPhPs to heat transfer.

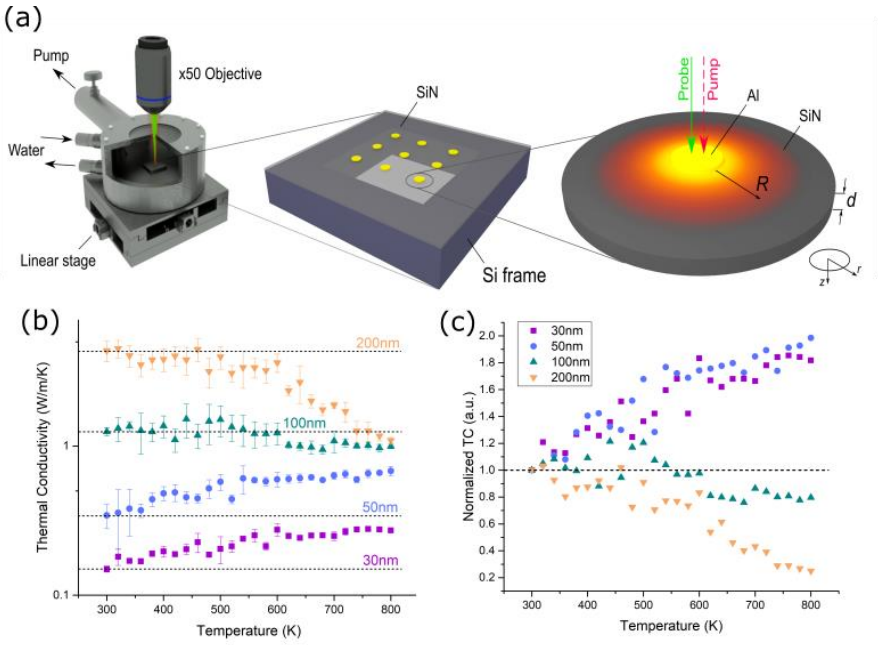


*Fig. 1. (a) Schematic of a heating stage and a sample, (b) thermal conductivity as a function of temperature with different thicknesses, (c) thermal conductivities normalized by the one at room temperature, revealing the SPhPs contribution in thinner samples.*

Figure 1 shows the thermal conductivity (TC) of silicon nitride films with different thicknesses measured from 300 to 800K. Stronger 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 Umklapp scattering. The results presented here have future applications in the field of heat transfer, thermal management, near-field radiation and polaritonics.

**Acknowledgements** This work was supported by CREST JST (JPMJCR19Q3) and Kakenhi (15H05869 and 17H02729).