# Thermal transport by surface phonon polaritons in SiN nanofilms

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Thermal conduction becomes less efficient as structures scale down into submicron sizes due to the predominant phonon-boundary scattering that hinders phonons more efficiently than Umklapp scattering. Recent studies indicated that this thermal performance reduction could be avoided by using surface phonon-polaritons (SPhPs), which are evanescent electromagnetic waves generated by the hybridization of optical phonons and photons. These waves propagate along the surface of polar dielectric materials and could be heat carriers capable of remarkably enhancing the thermal performance of micro- and nanoscale devices. We experimentally observe the dominant heat contribution of SPhPs in SiN nanofilms

Figure 1 shows the measurement setup and thermal conductivity of four SiN nanomembranes (thickness: 30-200 nm) at different temperatures ranging from 300 and 800 K. The thermal conductivity of the membranes thinner than 50 nm increases with temperature, as expected for the SPhP contribution, while that of a 200 nm-thick membrane decreases, in agreement with the phonon counterpart (Fig. 1c). In general, the thermal conductivity decreases as the temperature increases due to more frequent phonon-phonon scattering. However, the two thinner membranes, i.e. 30 and 50 nm-thick membranes, become twice more conductive when their temperature rises from 300 to 800 K [1]. This behavior represents the fingerprints of SPhPs: much longer propagation length of SPhPs ~ mm, while the mean free paths of phonons are below 100 nm [2]. The hybridization of phonons with photons enables ultrafast thermal transport in such a system.

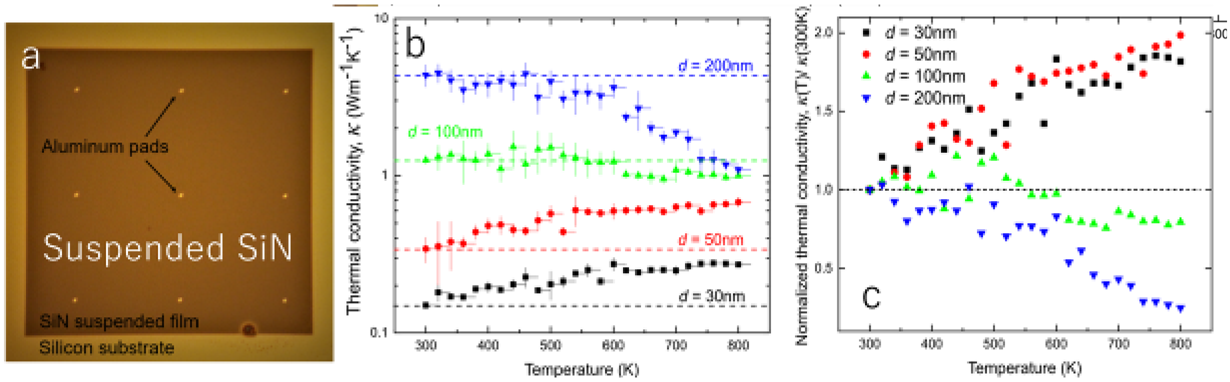


**Fig. 1.** (a) Optical microscope image of the sample. (b) Thermal conductivity as a function of temperature, for SiN membranes with different thicknesses. (c) Thermal conductivity normalized by the value at room temperature.

## References

[1] Y. Wu et al., Sci. Adv. 6, eabb4461 (2020). [2] Y. Wu, et al., Appl. Phys. Lett. 121, 112203 (2022).