Variable-temperature SNOM imaging of long-propagating phonon-polaritons in strontium titanate

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Surface phonon polaritons—light coupled to lattice vibrations—in polar crystals offer an opportunity to achieve low optical losses and enhanced photonic density of states in the mid-IR to THz spectral ranges, which are of great importance for the applications of biosensing, optical imaging and energy harvesting. Here we firstly report a cryogenic near-field spectroscopic study of phonon polaritonic response at the interface of $SrTiO_3$. We observe a temperature dependence of far-infrared phonon polaritons. Specifically, the phonon polariton propagation length can exceed 100 micrometers at liquid nitrogen temperatures. More importantly, by fabricating $LaAlO_3/SrTiO_3$ heterostructure, we observe a blue-shift of the phonon peak comparing with pure $SrTiO_3$. Our experimental findings are accurately supported with theory. Thus, $SrTiO_3$ is confirmed as a new and potential polaritonic material of the perovskite family, which would be beneficial for the understanding and design of future polaritonic devices.