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Longitudinal acoustic phonon modes in ultra-thin GaAs resonator[1] MAXIM ZALALUTDINOV, DOUGLAS PHOTIADIS, SAM CARTER, ALLAN BRACKER, Naval Research Laboratory, Washington, DC 20375, USA, MIJIN KIM, Sotera Defense Solutions, Inc., Columbia, Maryland 21046, USA, CHUL SOO KIM, DAN GAMMON, BRIAN HOUSTON, Naval Research Laboratory, Washington, DC 20375, USA — A nanomechanical thin-plate resonator implemented in GaAs and operated in SHF band, with the fundamental mode at 13GHz is presented. An increase in the resonant frequency by factor of 5x, compared to GaAs devices featuring in-plane extensional modes is provided by invoking longitudinal soundwaves that match the submicron thickness of the suspended GaAs plate (aka organ-pipe modes). An ultrafast optical pump-probe setup was used to excite and to readout the mechanical motion of the nanostructure. We present experimental data showing the optical response to SHF sound waves and a model for the transduction mechanism. Our analysis highlights the lateral confinement of the elastic Lamb-type waves in a suspended plate as a prime factor that governs the energy loss in our resonators. The ability to alter the degree of such confinement for elastic excitations in membranes using nano-patterned structures allows one to implement a wide range of acoustic devices from an isolated cavity to phononic waveguides and to couple them to optical structures. Given the atomic layer precision in MBE-grown GaAs film thickness and a wide range of optical devices available in GaAs we anticipate that demonstrated control over high frequency phonons will open new opportunities in optomechanics.

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