Supplementary Material:

Nonlinear effects in locally-resonant nanostrip phononic metasurface at GHz frequencies

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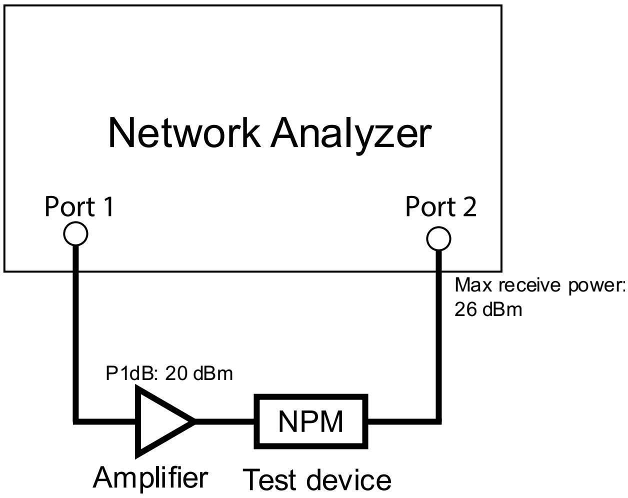

Fig. S1 Test set up for measuring the impedance of the NPM resonator at different stimulation power.

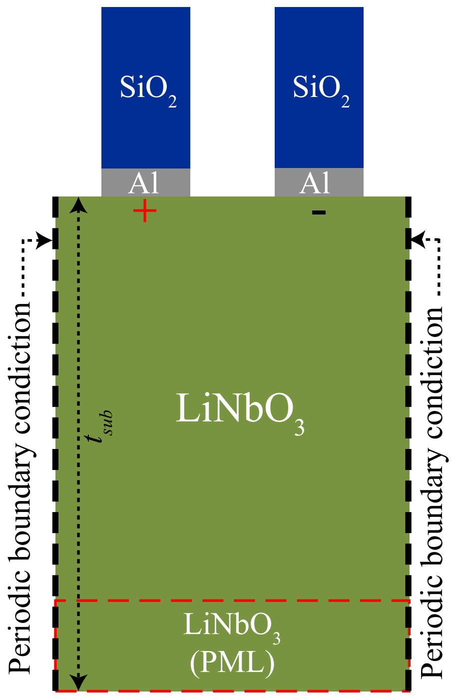

Figure S2. FEM simulation model of the NPM resonator.

Fig. S2 shows a diagram of the FEM simulation unit cell of the NPM resonator. The width of the unit cell is set to one wavelength (1 μm). Periodic boundary conditions are applied to the two sides of the unit cell, which is equivalent to repeating the unit cell and making an IDT of infinite finger pairs. As the model is in 3D, periodic boundary conditions are also applied to the front and back sides, which is equivalent to extending the acoustic aperture to infinite. The thickness of the $LiNbO_3$ substrate (t_{sub}) is set to 5 wavelengths. The bottom one wavelength of the substrate is set as a perfectly matched layer (PML), which adsorbs all the waves entering it and effectively extends the substrate depth to infinite. PML and periodic boundary conditions simplify the model and reduce the computation time. The nanostrip is made of 680-nm SiO_2 and 75-nm Al. Its width is 250 nm. An alternating potential is applied to the Al electrode for piezoelectric stimulation. It should be noted this theoretical model does not include the Ti adhesion layers because their small thickness significantly increases the mesh size and thus greatly increases the computation time. The thickness of the Ti layers is directly accounted by the Al layer. As the Ti layers are very thin and are very small portions of the nanostrip, this approximation has a very limited impact on the simulation results. The properties of the materials used in the FEM simulation are listed in Table S1. The properties of the lithium niobate substrate are obtained from the manufacturer (Roditi) website.

Table S1. Properties of the materials used in the FEM model of the NPM resonator.

Material	Density (kg/m^3)	Young's modulus (GPa)	Poisson's ratio	Relative permittivity
Aluminum	2700	70	0.35	NA
Silicon dioxide	2650	66	0.17	3.9
Lithium niobate	4647	Elasticity, coupling and relative permittivity matrix are available at: http://www.roditi.com/SingleCrystal/LiNbO3/liNBO3-Properties.html		

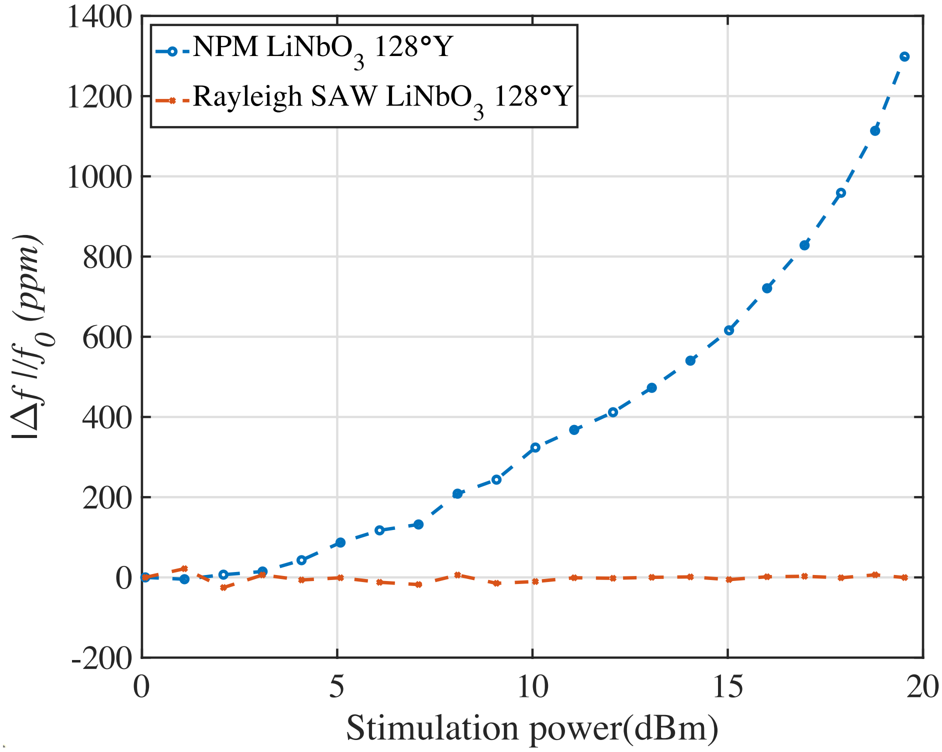

Figure S3. Comparison of resonance frequency shift of the NPM resonator with the conventional Rayleigh SAW resonator. The resonance frequency of the Rayleigh SAW resonator remains constant in the stimulation power range of 0~19.5 dBm.