Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Microwave cavity piezo-opto-mechanical resonators based on film thickness modes operating beyond 10 GHz XU HAN, HONG TANG, Yale University — Micromechanical resonators, which support and confine microwave frequency phonons on a scale comparable to optical wavelength, provide a valuable intermediate platform facilitating interactions among electrical, optical, and mechanical domains. High-frequency mechanical resonances ease the refrigeration conditions for reaching quantum mechanical ground state and also hold promise for practical device applications. However, efficient actuation of the highly stiff mechanical motions above gigahertz frequencies remains a challenging task. Here, we demonstrate a high-performance piezo-opto-mechanical resonator operating at 10.4 GHz by exploiting the acoustic thickness mode of an aluminum nitride micro-disk. In contrast to the in-plane mechanical modes, the thickness mode can be easily scaled to high frequencies with low mechanical and optical dissipations. A high $f \cdot Q$ product of 1.9×10^{13}?Hz is achieved in ambient air at room temperature. Moreover, strong piezo-electro-mechanical coupling can be achieved by coupling the thickness mode with a microwave resonator, making it possible for coherent signal conversion. The thickness mode-based piezo-opto-mechanical resonators can be expected to serve as essential elements for advanced hybrid information networks.

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Date submitted: 06 Nov 2015 Electronic form version 1.4