Design and Fabrication of Piezoelectric Coupled MEMS Resonators

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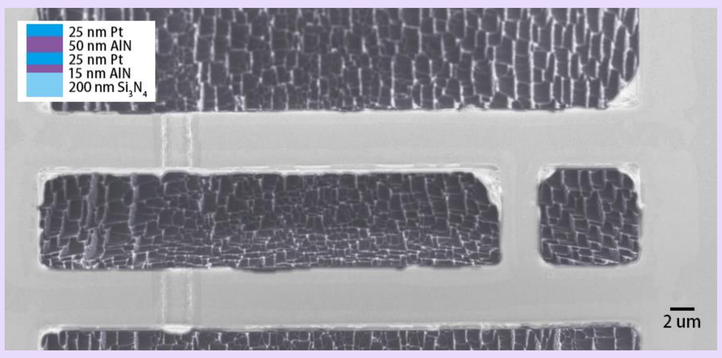
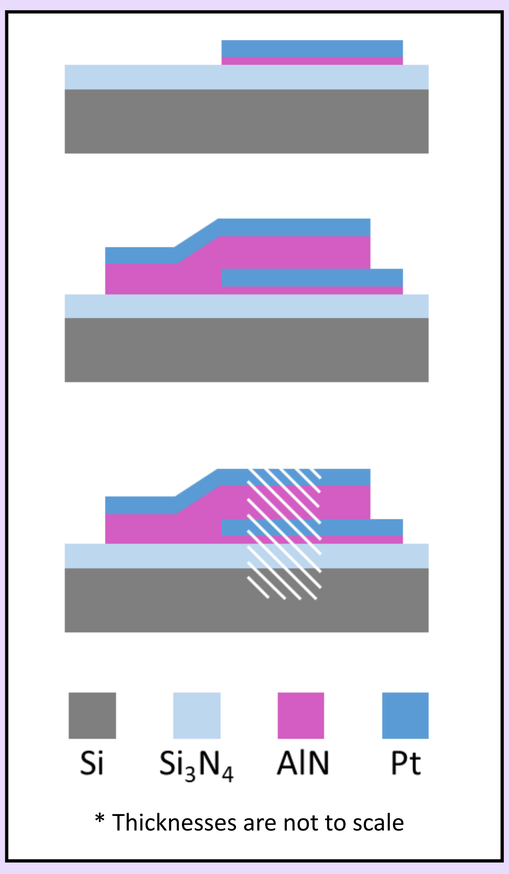
Abstract

- **We fabricated weakly coupled clamped-clamped beams and cantilevers with platinum electrodes and aluminum nitride piezoelectric layer.**
- **We studied the resonance frequencies of clamped-clamped beams.**
- **We studied the influence of geometric parameters on coupling strength and compared with FEM modeling results.**



SEM of one coupled clamped-clamped beam with thickness cross section shown inside.

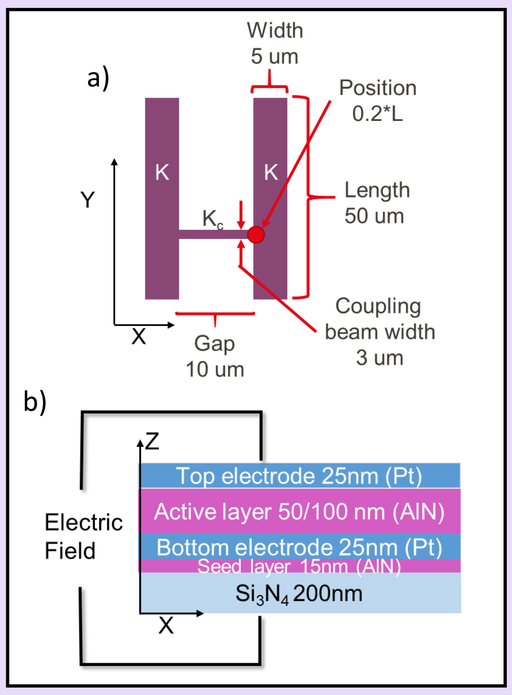
Fabrication



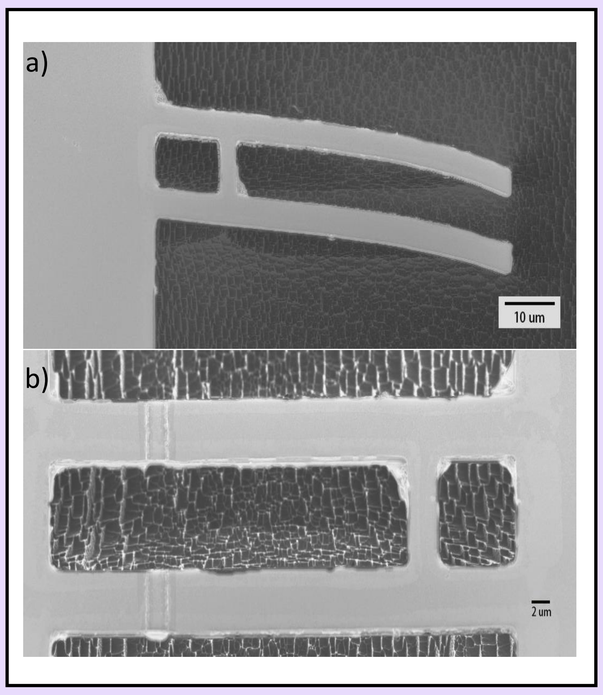
Lift-off bottom electrode and seed layer

Deposition and patterning of AlN and top electrode

Patterning and release of coupled resonators



Design and geometric parameter values.

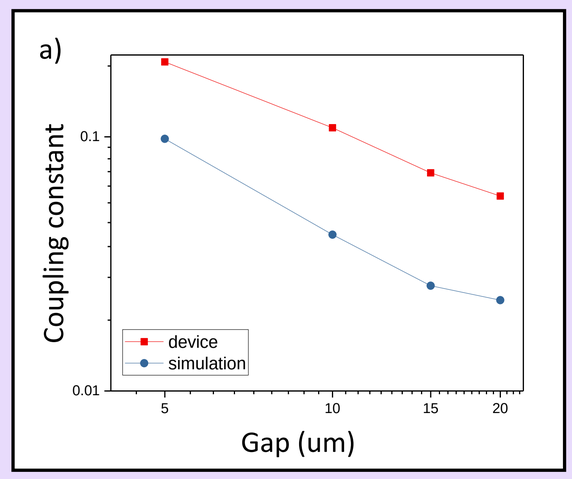


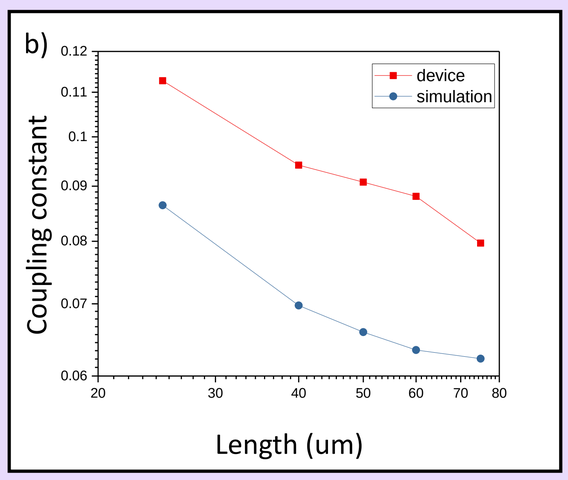
SEM pictures of a) cantilever and b) clamped-clamped beam.

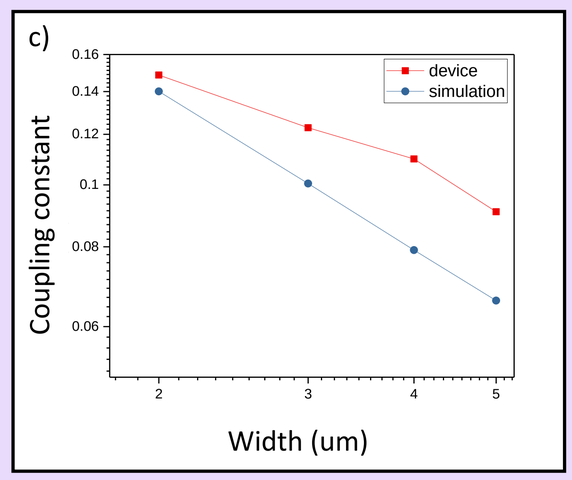
Characterization

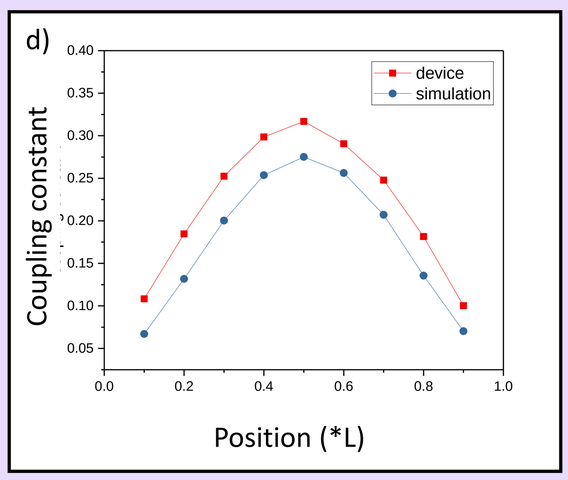
- The in-phase and anti-phase first mode resonance frequencies were studied.
- The coupling constant can be calculated as equation shown below:

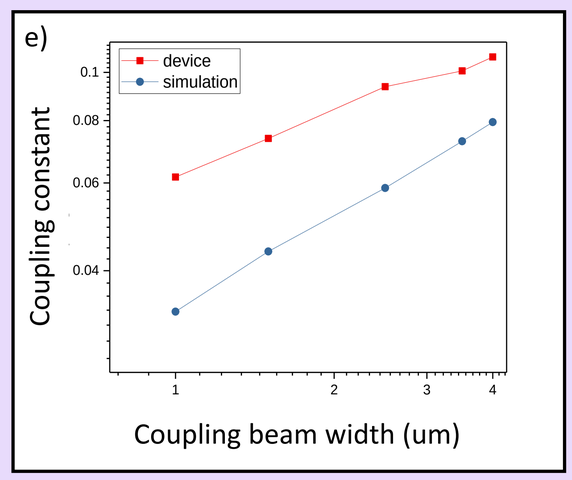
$$\kappa = \frac{K_c}{K} = \frac{f_{anti}^2 - f_{in}^2}{2 * f_{in}^2}$$ [1]





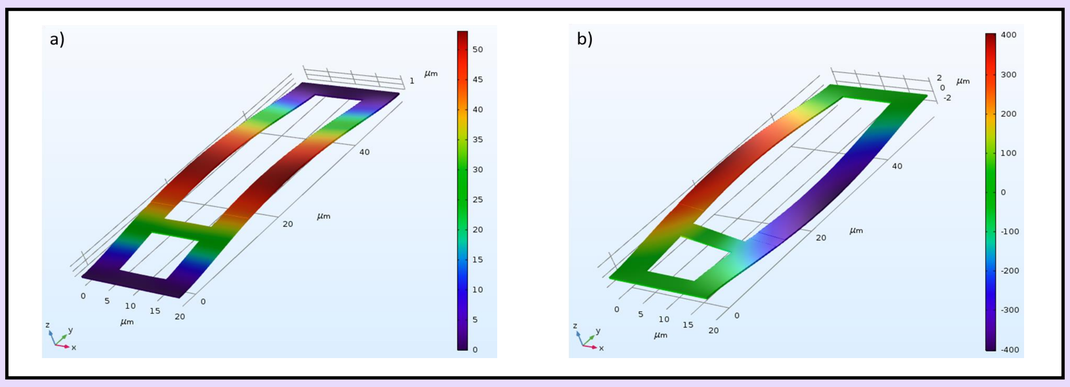






Coupling constant with variable a) gap b) beam length c) beam width d) coupling beam position e) coupling beam width.

FEM model



Examples of Comsol simulation results of a) in-phase vibration and b) anti-phase variation with 250MPa compressive residual stress.

Conclusions

- The measurement results of coupling constant show the same trends with simulation results.
- Increasing the beam length, width and gap can decrease the coupling strength, and decreasing the coupling beam width or putting the beam at vibration nodes can also achieve this goal.

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References:
[1] Eduardo Gil-Santos etc. Exponential tuning of the coupling constant of coupled micro-cantilevers by modifying their separation. Applied physics letters, 98(123108), 2011.