

DOME-SHAPED-DIAPHRAGM RESONATORS WITH WINE-GLASS MODE VIBRATION

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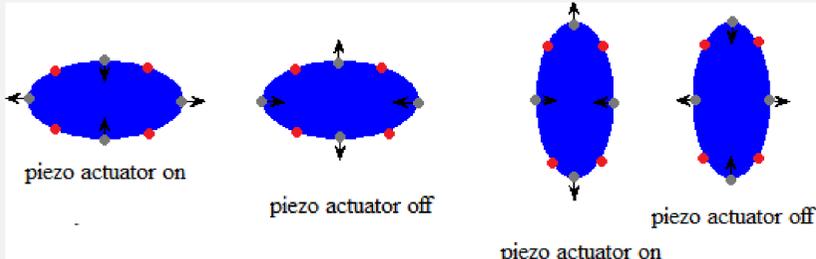
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Motivation

- Measurement of angle and orientation has always been very important in different application from smartphones to missiles and space-ships.
- Gyroscopes are sensors for these measurements.
 - Hemispherical Resonator Gyroscope has been the choice for high value space missions due to their high performance small size and no wear out.
 - We are trying to design a micro version of these already largely used devices.
 - First step to do so is to design a dome-shaped-diaphragm resonator with wineglass mode vibration.

Design

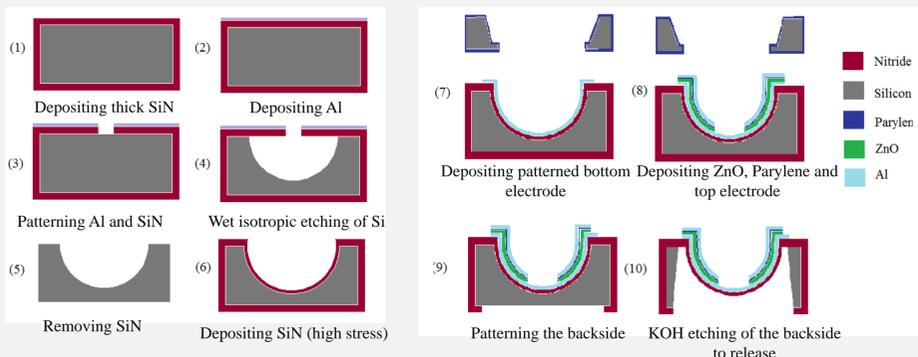
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How a 4-node wineglass mode is produced by the four piezoelectric transducers mounted on the anti-nodal lines of the dome diaphragm

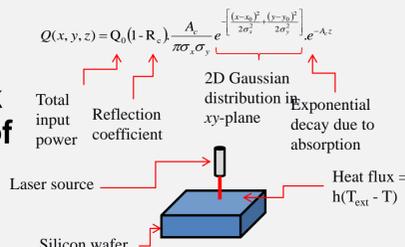
Fabrication

- A batch process with silicon wafer, based on isotropic etching of silicon

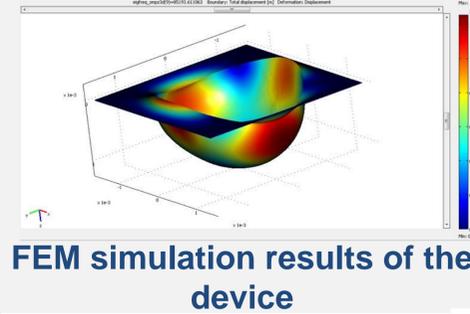


Fabrication Process alternative

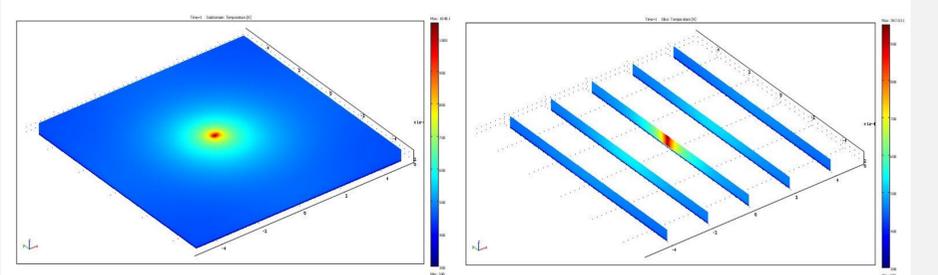
- In order to achieve larger dome and considering our limitation due to etch mask we came up with the idea of damaging silicon before etching using a laser



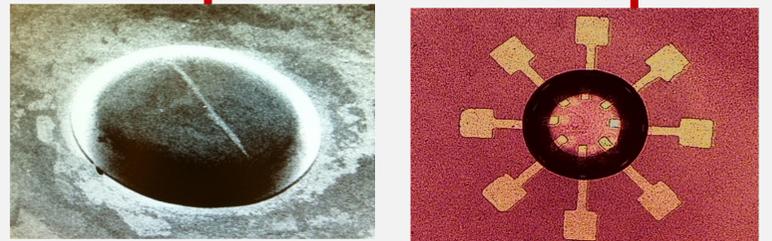
Simulation Results



- Finite Element Method simulation results of our device:
 - 4 node wineglass mode has been observed in the designed frequency.



Fabricated Device and Experimental Setup



SEM image of backside of the device and a picture of top side of the transducer showing the electrodes



Board and electrical connections for actuation and sensing

Experimental Results

- We have 4 actuators and 4 sensors, actuators also can be used as sensors.
 - In order to show 4-node wineglass mode resonance we actuate two actuators on every other side of the device (1 and 5 in the left picture) and monitor sensors.
 - If we have 4-node wineglass mode resonance we expect to see a signal at the middle sensor (3 in the picture) which is 180° out of phase from actuation signal.
 - We approved these results by measurement (left side picture)

