Design and Multiphysics analysis of MEMS capacitive Microphone

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Introduction: Micro-Electro-mechanical system or MEMS, is a technology of Very small systems that are made using technique of microfabrication. MEMS technology is widely used in microphone fabrication. A microphone is an acoustic to electrical transducer or sensors that converts sound into electrical. Most surface and bulk micromachined capacitive microphone uses fully clamped diaphragm with Perforated back plate. The cavity or back chamber is etched into substrate by KOH etching. Cavity forming by KOH etching is slow and time consuming process. This complex and expensive fabrication can be avoided by making holes in diaphragm. The corrugated diaphragm can provide large deflection than flat diaphragm for equivalent load. Thebcorrugation in diaphragm reduces residual stress and increases mechanical sensitivity of microphone.

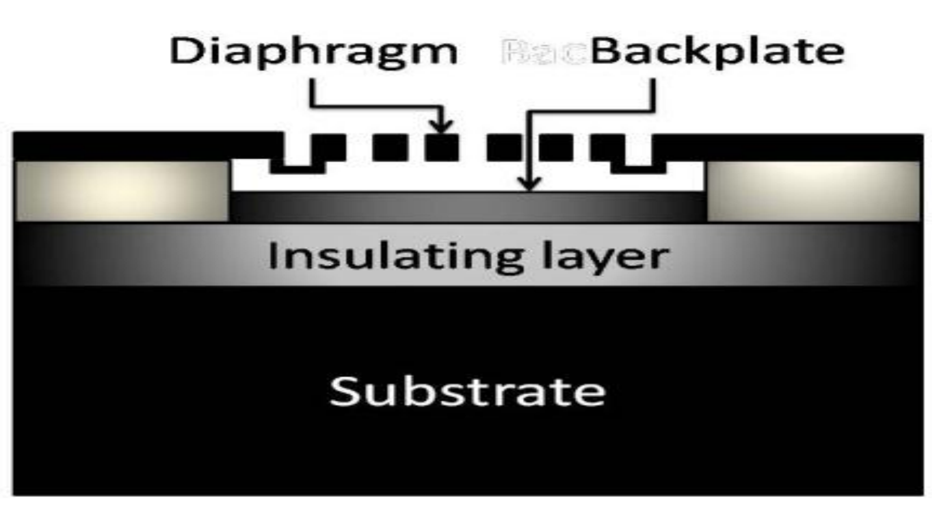

Figure 1. Cross section view of capacitive microphone with corrugated and perforated diaphragm Creating

Computational Methods: An electrostatic force caused by applied potential difference between the diaphragm and back plate bends the diaphragm towards back plate beneath it. As the diaphragm bends, the geometry of air gap changes continuously, resulting a change in electric field.The coupled physics is handled automatically by the Electromechanics interface. The force density that acts on the diaphragm of microphone results from Maxwell's stress tensor:

$$F_{es} = -{}^{1}/_{2}\,(E\,.\,D)n + (n\,.\,E)D$$

where **E** and **D** are the electric field and electric displacement vectors, respectively, and **n** is the outward normal vector of the boundary.

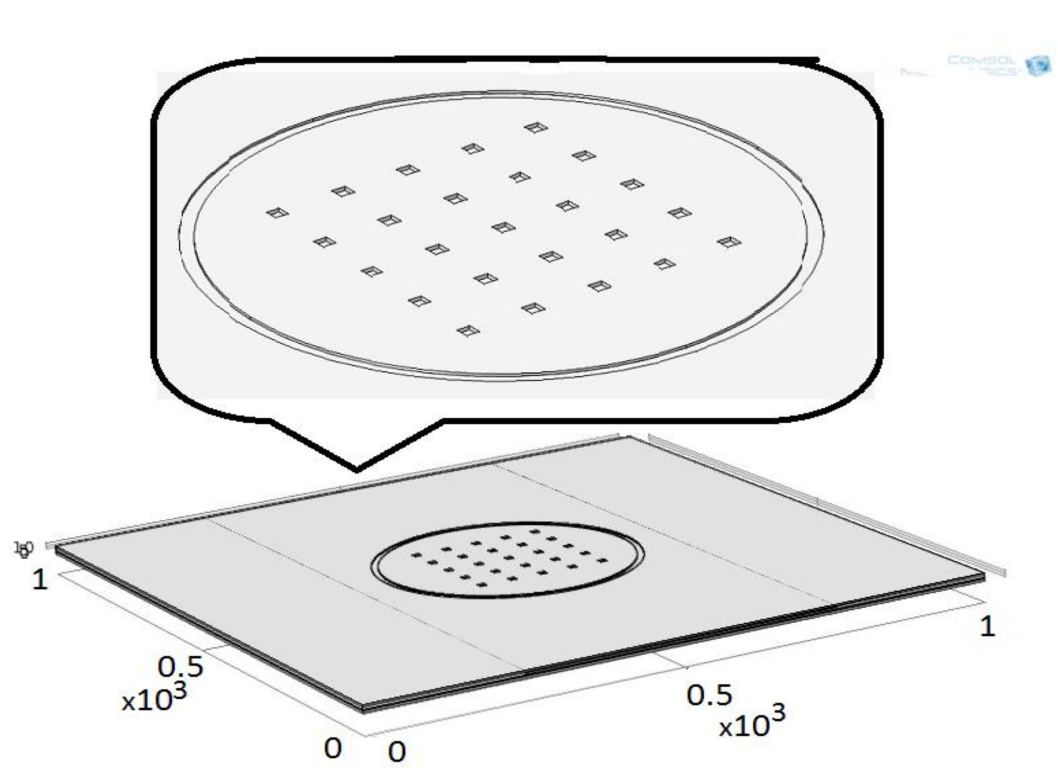

Figure 2. 3D model of capacitive microphone with corrugated and perforated diaphragm

Results:

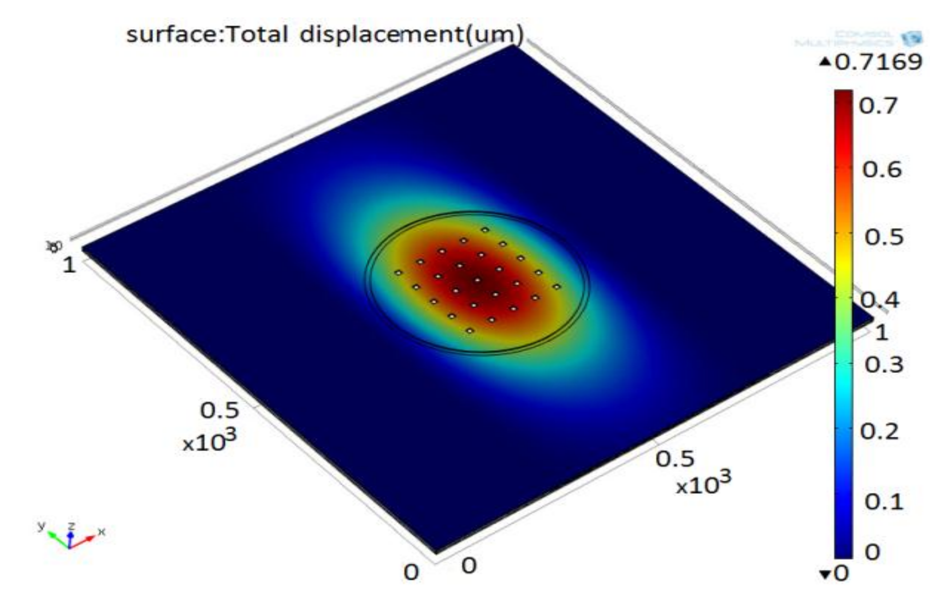

Figure 3. Displacement analysis of capacitive microphone with corrugated and perforated diaphragm

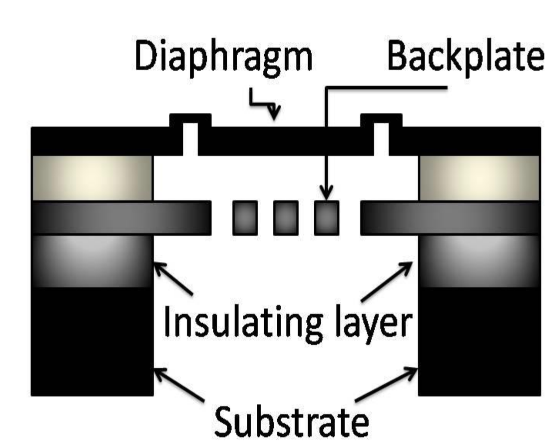

Figure 4. crosss section view of capacitive microphone with perforated back plate.

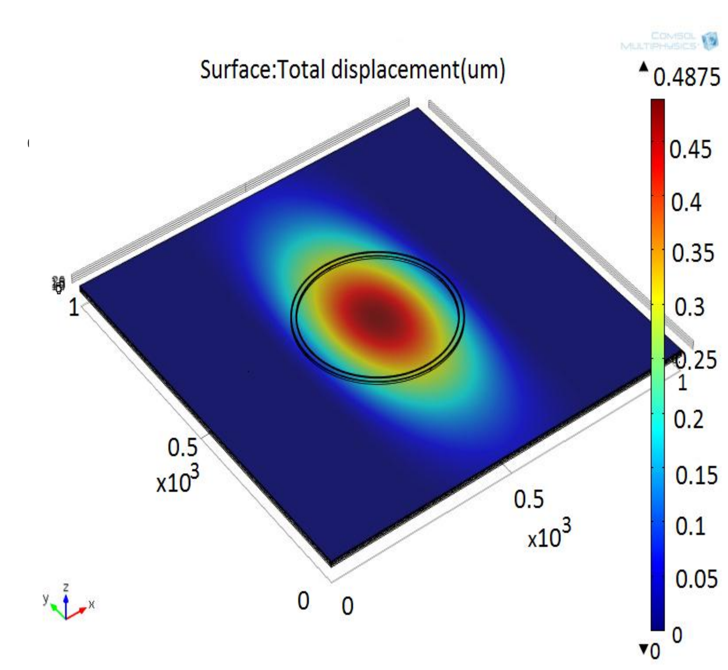

Figure 5. Displacement analysis of capacitive microphone with perforated back plate.

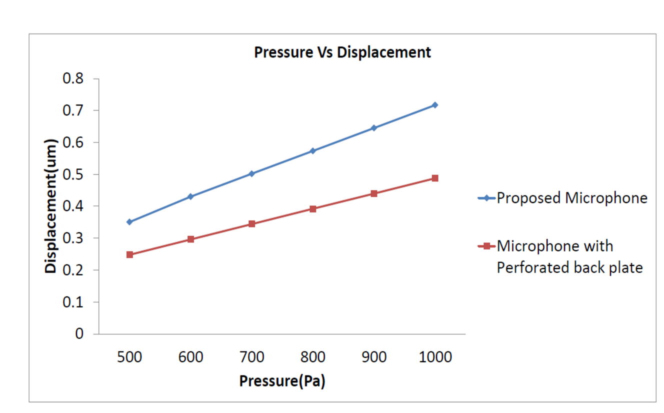

Figure 6. Pressure-Deflection plot.

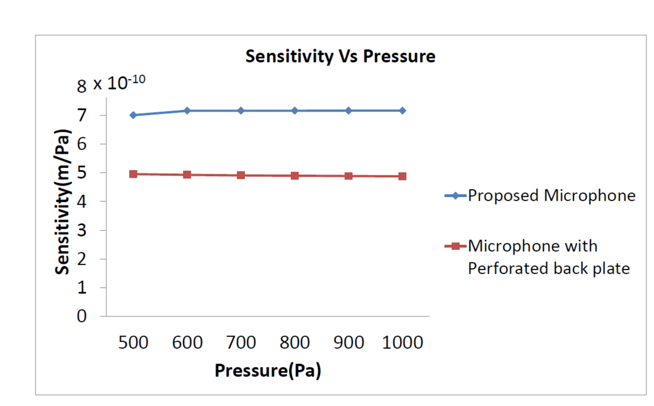

Figure 7. Sensitivity Vs Pressure plot.

Conclusions: MEMS capacitive microphone with corrugated perforated diaphragm is presented. The result is compared with capacitive microphone with perforated back plate. The microphone sensitivity is increased while complex and expensive fabrication is avoided by making holes in the diaphragm instead of back plate. The result shows center deflection of capacitive microphone with corrugated perforated diaphragm is 0.7169µm and capacitive microphone with perforated back plate is 0.4875µm. This shows sensitivity and deflection of proposed microphone is more than microphone with perforated back plate.

References:

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