Design and Simulation of MEMS-based Piezoelectric Accelerometer

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Introduction:

MEMS is a platform to combine mechanical and electrical components on unique base. Accelerometers had the unique feature to measure acceleration, in which the type which releases energy for the measurements are of this type.

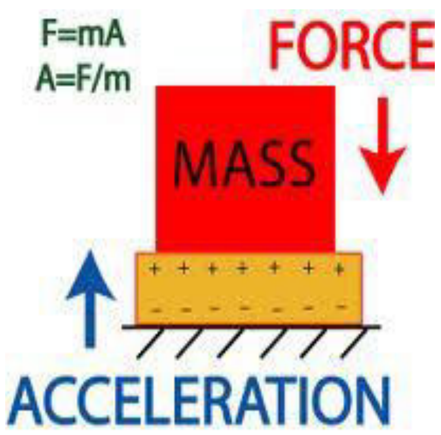

fig.1:Piezoelectric principle

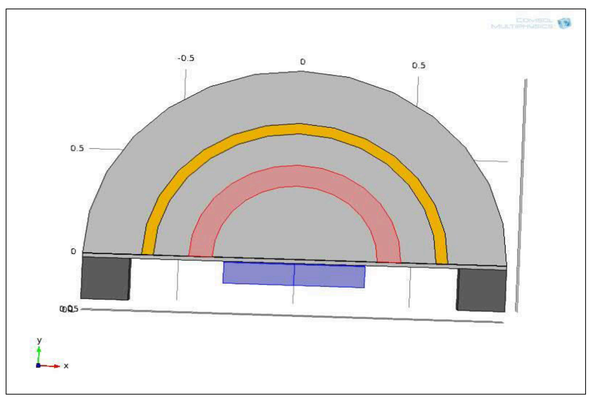

Figure 2. Design of Accelerometer

Construction & Computation: The construction of this design involves two stages. They are, setting of geometry, applying of materials required to the respective domains. According to the mathematical basis,

$$a = \frac{k\Delta s}{m} - g$$

$$\ddot{x} + 2\xi\omega_n \dot{x} + \omega_n^2 x = 0$$

Computation is done to study the results with the help of required parameters and different analysis procedures. For the evaluation of good results, the simulation is done with different geometries, materials.

The meshing of the constructed design is done in the way of analysis for equal distribution and exact results.

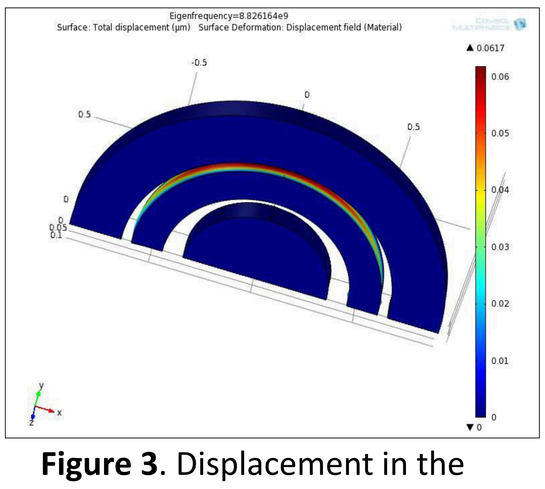

Figure 3. Displacement in the piezoelectric layer

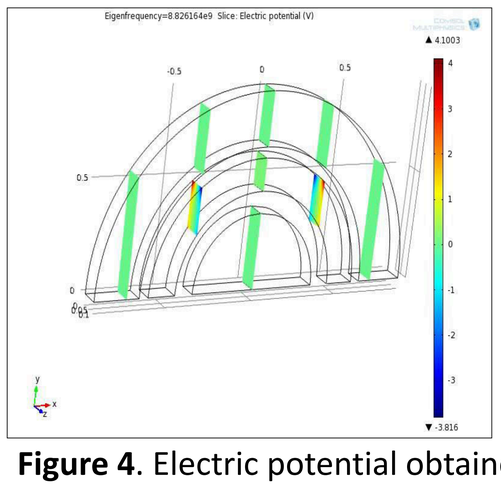

Figure 4. Electric potential obtained

Here the results are noticed to be 0.0167 displacement with a potential of 4.1003V. So from this we can say that this good sensitivity but the better we can use when we simulate with the other.

Results: Results from the simulation, sensitivities and potentials obtained are as follows.

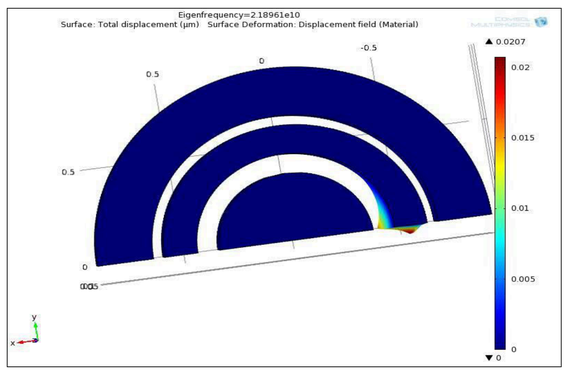

Figure5. Displacement for Quartz

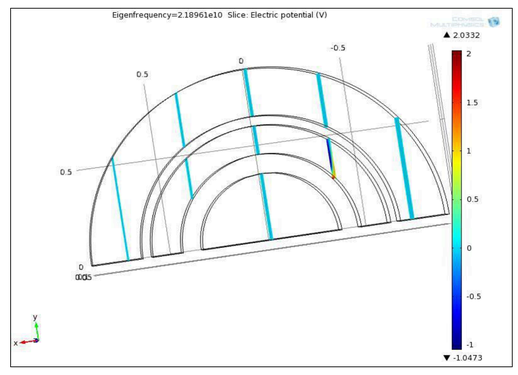

Figure 6.Potential obtained for Quartz

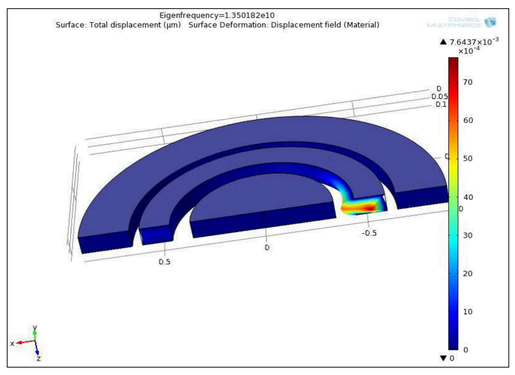

Fig7:Displacement for ZnO

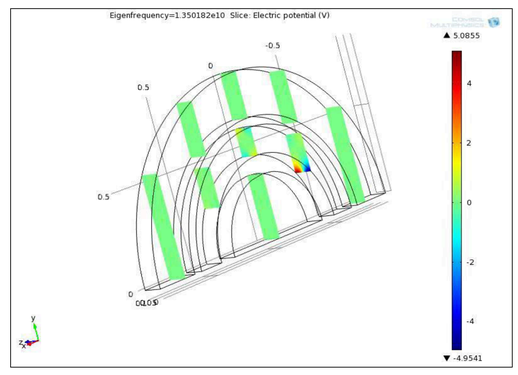

Fig 8:Potential obtained for ZnO

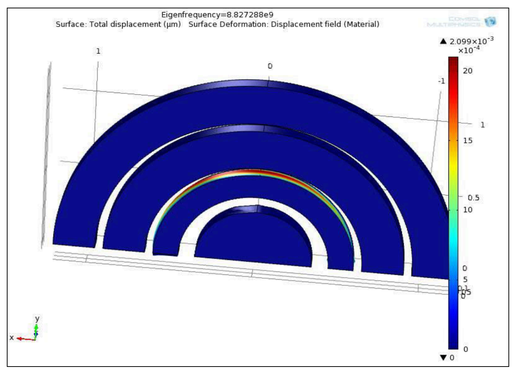

Fig 9: Displacement for the varied geometry

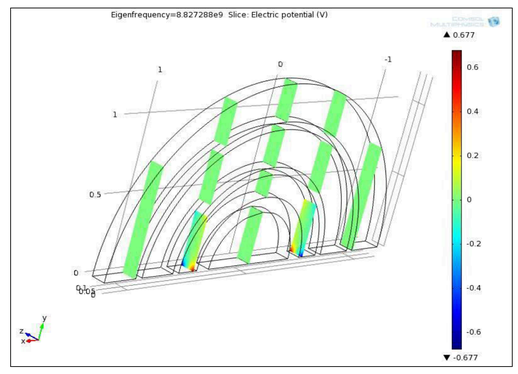

Fig 10:Potential obtained for the varied geometry

Result type	Type of construction	3 layer with lead zirconate titanate	3 layer with quartz	3 layer with ZnO	4 layer with lead zirconate titanate
Displacement (µm)		0.0167	0.0207	$7.6437*10^{-4}$	$2.099*10^{-7}$
Potential (V)		4.1003	2.0332	5.0855	0.977

Conclusions: The analysed model in this project gives very good results and good potential output as its thickness and its size is very low it can also be practically possible to construct with the help of obtained results. ZnO and PZT films are the two primary materials reported for use in bulk- or surface-micromachined piezoelectric MEMS accelerometers.

References:

[1]. N. Yazdi, F. Ayazi, and K. Najafi, “Micromachined inertial sensors,” Proc. IEEE, vol. 86, pp. 1640–1659, Aug. 1998.

[2]. C. Song, B. Ha, and S. Lee, “Micromachined inertial sensors,” in Proc. 1999 IEEE/RSJ, International Conference on Intelligent Robots and Systems, vol. 2, pp. 1049–1056.

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