MEMS Based Mass Sensor With Uniform Sensitivity For Biological Applications

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Introduction:

- MEMS devices exhibit rapid response with minimum sample volume at higher sensitivities. This makes them suitable for detection of Micro/nanoparticles and can also use to monitor their physical process at that minute scales.
- Micro-cantilevers based sensing is widely used in biosensor applications and the detection of mass using them is extensively carried out in the fields of chemical and biology, in which sensitivity is a major challenge.
- The sensitivity of the microcantilever profoundly depends upon their dimensional, structural and material scalabilities.
- In rectangular based cantilevers having the challenge of non-uniform sensitivity with respect to the position of the binding molecule on the surface of cantilever for the precise mass sensing.
- This challenge can be endorsed by using uniform mass Sensitivity

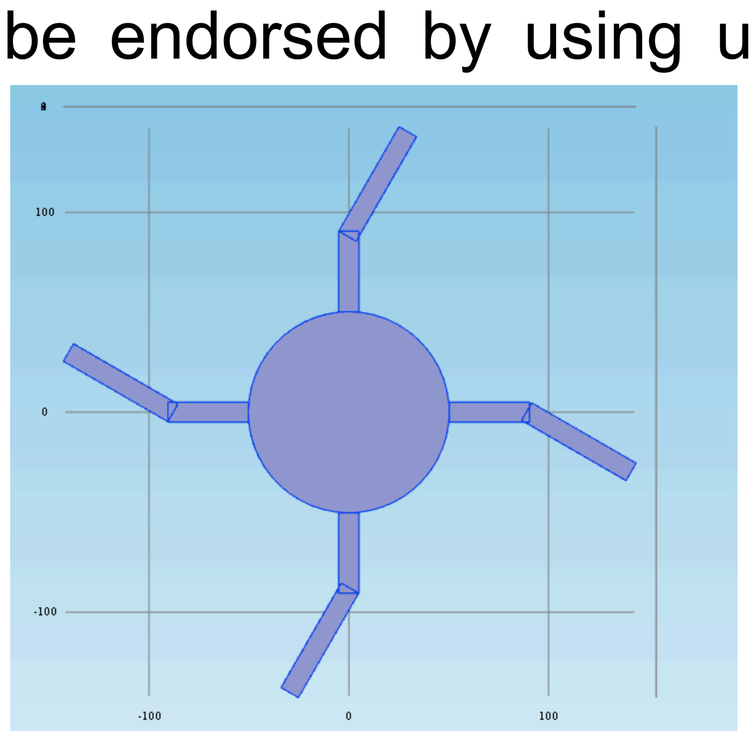

Figure 1. MEMS based Circular disc for Uniform Mass Sensing

Computational Methods:

1. The Geometry is designed using work plane in 2D and extruded for 3 Micron in Z-axis plane. The physics considered in solving is Structural physics with solid mechanics to check the principle stress and strain with stationary analysis under no load conditions.
2. Later the Eigen frequency study is carried out to determine the principle mode or lateral movement of the structure, upon which the frequency analysis is carried out at the principle mode with material sweep and parametric sweep for load condition.
3. The Geometry is consisting of the circular proof mass with four cantilever cantilevers with suspended with an angle of 30 degrees. The device is fixed at the four corners of the cantilevers.

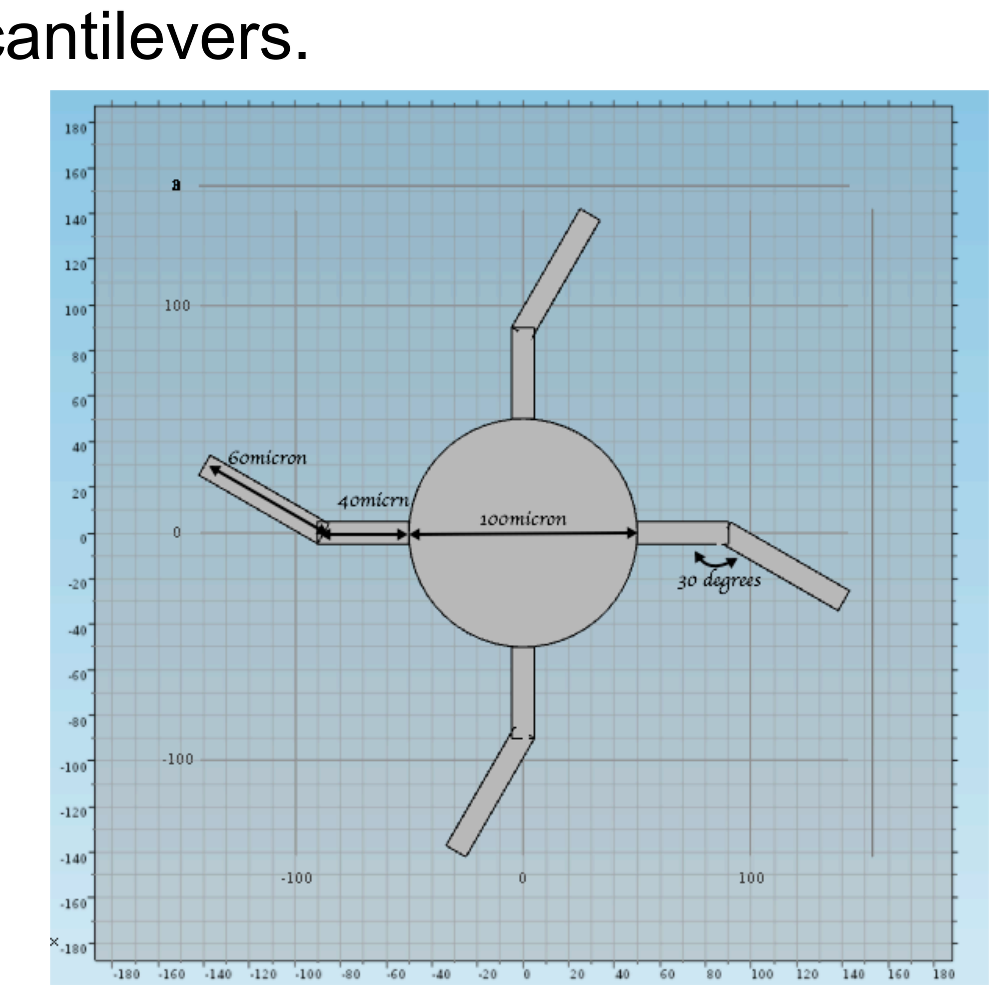

Figure 2. Structural Dimension of the Rsuspended Resonator

Results:

The materials for the device are considered with Switch case where Silicon, Silicon dioxide, Silicon Nitride and Silicon Carbide are considered for the material sweep. In Eigen frequency analysis the principle mode for each is case obtained and Load is considered as parameter where parametric sweep is considered for added mass from 1 femtogram to 1 attogram. The shift in frequency is calibrated in among materials silicon nitrite showing the promising for device fabrication. The highest frequency shift is shown by Silicon Carbide and Silicon Nitrite which is around 27.66Hz/picogram and 24.78Hz/picogram respectively.

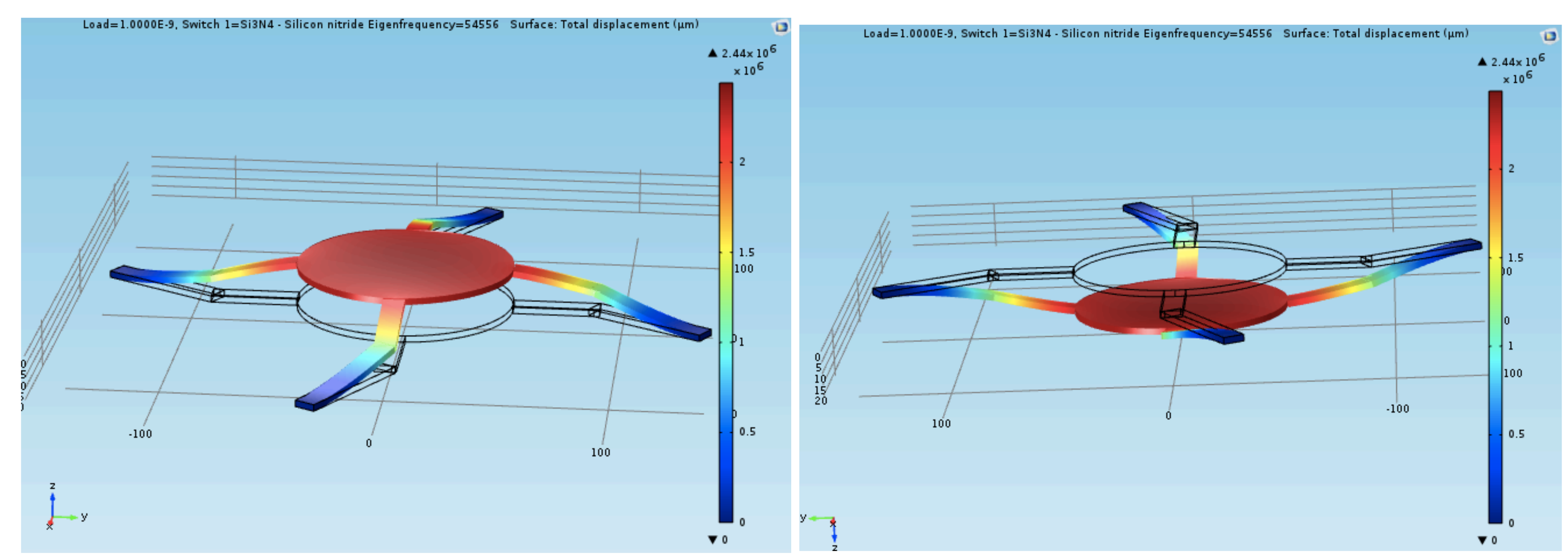

Figure 3. Stationary and Dynamic Mode analysis of the Structure

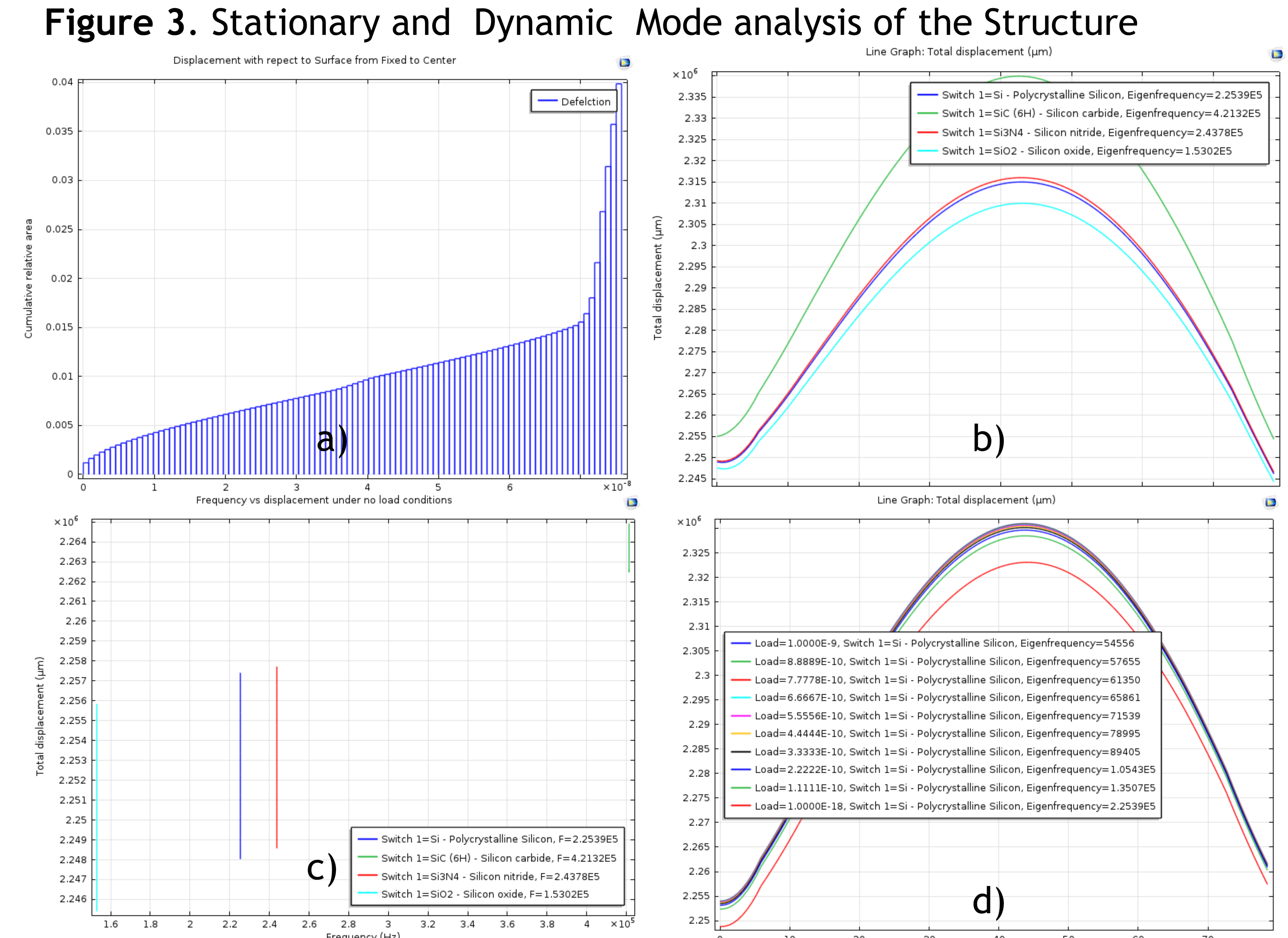

Figure 4. a)Displacement from fixed end to centre of device b) displacement along the axis in dynamic analysis c) material Sweep d) parametric sweep

Conclusions:

The paramedic sweep of the added mass determines the sensitivity of the device which is highest around 27Hz/picogram and the material sweep is used for the quality factor determination which is high for silicon carbide and silicon Nitrite.

References:

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