

# Modeling and Analysis of Different Shaped Cantilever Beams in MATLAB

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**Abstract-** Cantilever beams find their application in Biosensors like Glucose sensors and Gas leak detectors because of their characteristics like ability to render measurable mechanical responses quickly and sensitivity to miniscule amount of external force. Due to its variable features analysis of cantilever beams is very important. This paper deals with the modeling and analysis of different shaped Cantilever beams using MEMS Module in MATLAB.

**Keywords:** MEMS, Cantilevers, Matlab

## I. INTRODUCTION

Cantilever beams can be analyzed in 3 different ways namely static, dynamic and transient analysis. By Static analysis, the deflection or bent of the cantilever beam due to force applied in the form of mass or any other type of force can be obtained. By dynamic analysis, the shift between the resonant frequencies for different parameters and applied conditions can be achieved. By transient analysis, we can obtain the number of modes and instantaneous state of a system as a function of time We simulate the mechanical devices and find their response and also simulate the deflection of a beam due to an external force, where the beam is fixed at one end. so this all leads to generate a net list and how to run the static analysis. Here for simulation we use two very important tools. MATLAB 7.4.0.287 is used as front end programming and SUGAR 3.1, which enables MATLAB to perform static and dynamic.

## II. MEMSMODULE

MEMS module we used here is SUGAR which has capability of performing static, dynamic and transient analysis. The description of a device can be given in a netlist format, and very quickly simulate the device's behavior. Using simple simulations in available, a user can quickly find problems in a design or try out new ideas. Element models at the structural and network levels are designed and

programmed providing using flexible language for device description. The framework supports for measurement comparison to validate existing models, derive new models, and extract physical parameters

## III. MODELING

The global model equation is given by

$$M\ddot{q} + D\dot{q} + Kq = F(t, q)$$

where  $M$  is mass matrix,  $D$  is damping matrix,  $K$  is stiffness matrix,  $q$  is matrix consisting of displacement translations and rotations about global axis.  $F$  is matrix containing corresponding forces and moments. In modeling the cantilever beam, we generate a netlist with the desired parameters and material with which it is to be designed. This netlist is provided to the MATLAB environment which has already provided with functions of MEMS module. Then in MATLAB workspace the necessary commands regarding the analysis to be performed are coded and corresponding outputs are obtained. Any changes regarding the structure of cantilever beam can be modified making changes in netlist.

## IV. RESULTS

By simulating with different parameters three different shaped cantilever beams are generated as shown in Fig 1, 2, 3

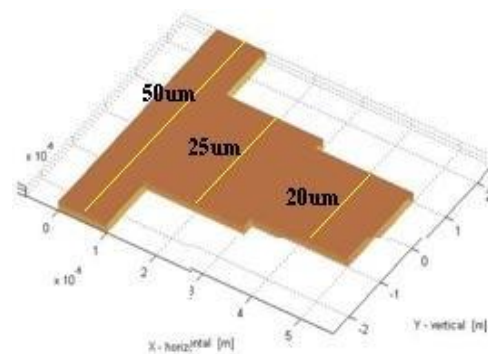


Fig1: Cantilever beam with Geometry  $W=50\mu\text{m}$ ,  $W1=25\mu\text{m}$ ,  $W2=20\mu\text{m}$

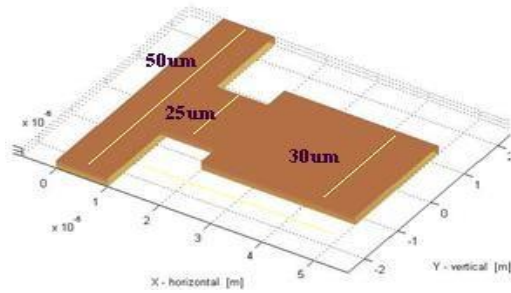


Fig2: Cantilever beam with Geometry W=50um, W1=25um,W2=30um

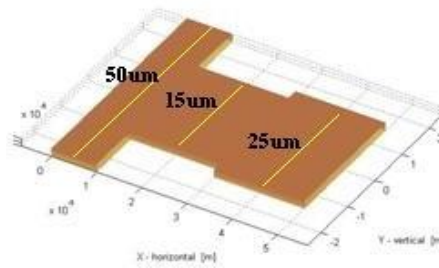


Fig3: Cantilever beam with Geometry W=50um, W1=15um,W2=25um

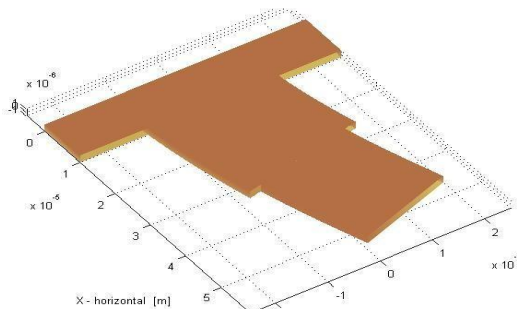


Fig4: Deflection in the Cantilever for the geometry of fig 1.

The deflection or the deformation in the cantilever upon application of force is observed and is represented as shown in the figure 4. The analysis is performed on the geometry specified in the fig 1. Similarly likewise the same is performed on the remaining geometries for knowledge on the deformation characteristics of the beams with forces in different directions.

V. CONCLUSION

Shapes of the cantilevers form basic sensing regions in BioSensors and their selection plays a major role regarding the selectivity and sensitivity of the target. In the above discussed procedure a simulation can be possible before actual fabrication. The tool also provides facility to perform transient analysis of these shapes.

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