Design and Optimization of Highly Sensitive Single Axis Accelerometer using COMSOL Multiphysics®

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Introduction: In this paper simulations of piezoresistive accelerometer system are shown. Piezoresistive accelerometer is made up of proof mass in center and springs with it for support. Piezoresistors are placed near the proof mass and frame ends. The simulations shows the von misses stress and and stress analysis of different structures using comsol 4.2a.

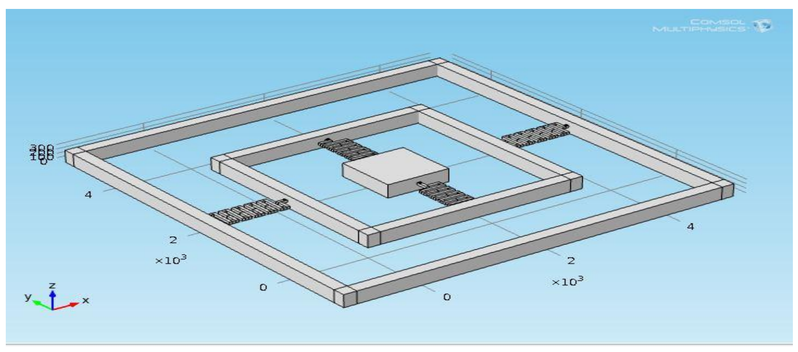

Figure 1. spring flexure based accelerometer

Computational Methods: In capacitive accelerometer main disadvantage is that they are highly prone to electromagnetic interference and involves considerable amount of parasitic component and main advantage of piezoresistive accelerometer is they are simple in structure, simple in fabrication. For simulation of this solid mechanics physics is used in comsol 4.2a. The formula used for deflection of flexures can be given as.

$$\delta = FL\,3 / 192EI$$

formula for change in resistance

$$\Delta R/R0 = \pi l \sigma l$$

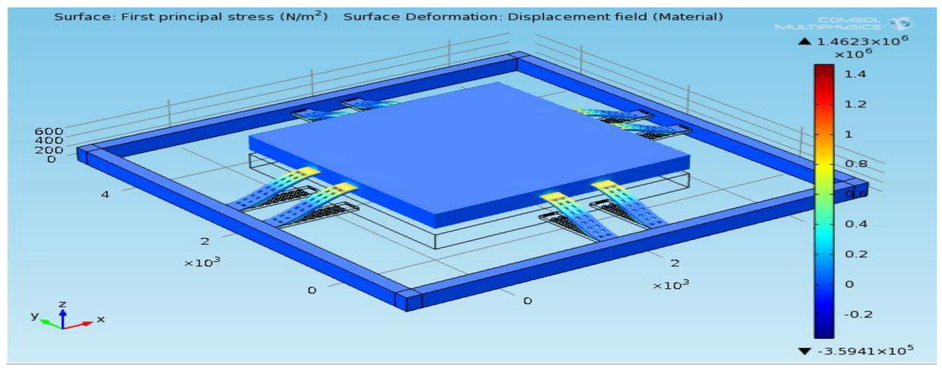

Figure 2. Flexures with holes piezoresistive accelerometer

Results: There are 3 structures which are compared in this paper so the simulations comparision shows the spring based structure is better than flexures with holes whose simlulation results are better than normal flexures.

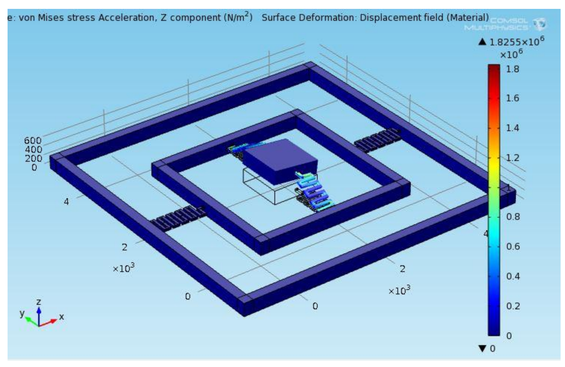

Figure 3. spring model

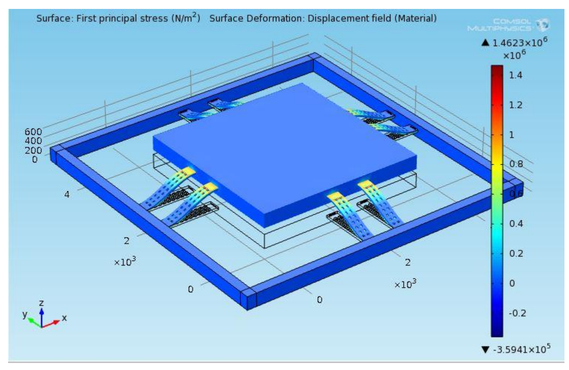

Figure 4. model with holes

DIRECTION	BASE PAPER MODEL WITH SUSPENSION BEAM	SPRING MODEL	MODEL WITH HOLES IN SUSPENSION BEAM
X	4.115×10^3	4.5051×10^5	5.536×10^3
Y	3.766×10^3	1.7955×10^5	5.676×10^3
Z	1.069×10^6	1.9529×10^6	1.42623×10^6
X-Y-Z	1.5149×10^6	4.8296×10^6	2.1569×10^6

Table 1. stress analysis Of all 3 models

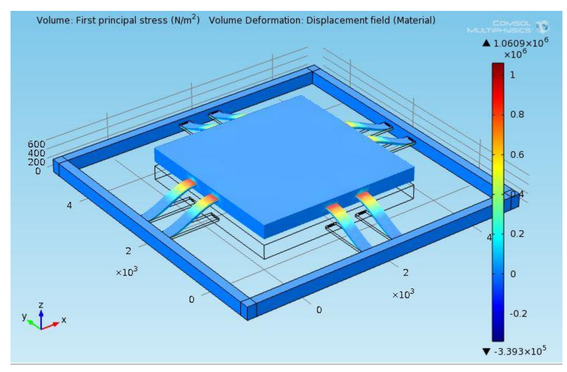

Figure 5. basic flexural model

Conclusions: The designs are very simple. The spring model is more efficient and very reliable as compared to the other two models. The structures prepared in this paper can be used in the air bag system in which accelerometer is used for blowing off the air bag in cars or vehicles.

References:

- E.jesper eklund and Andrei M shkel,"single mask fabrication of high G piezoresistive accelerometer", journal of micromech.microeng.,17,730-736(2007)
- S.kal,S.das,D.K.maurya,K.biswas,A. ravi sankar, "CMOS compatible bulk micromachined silicon piezoresistive accelerometer ", microelectronics, 17, 22-30 (2006)