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Comparison the Various Design of Cantilever MEMS Switch Using Electrostatic Actuation Method

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***Abstract*— A comparative study of various cantilever MEMS switch pull through Electrostatic actuation method. Two different cantilever switch is have been considered in the analysis. The both cantilever switch formation required material is same only the difference in geometry of switch. The switch is reduced the the fringing field effects and stress. The switch provides maximum deflection at pull in voltage. . The two shapes are used to provide maximum displacement i.e. rectangular shaped and Pi-shaped cantilever. The simulation result obtained maximum displacement and Electric potential by using COMSOL multiphysics software. The changes in geometry provide various displacements at pull in voltage.**

***Index Terms*— Cantilever, Electrostatic actuation, pull in voltage, MEMS switch, Electric potential.**

I. INTRODUCTION

(A MEMS cantilever switch is one which is fixed at one end and the other end is free to move when it experiences some stress. A Micro cantilever switch is a device that can be used as physical, chemical or biological sensor by detecting the changes in cantilever bending or vibrational frequency.. This deflection of micro cantilever changes when a specific mass of an analytic is specifically adsorbed on its surface similar to change when a person steps onto the diving board. But the micro cantilevers are a million times smaller than the diving board having dimensions in microns and different shapes [1]. In a MEMS device, a voltage bias is applied between two conductors. This voltage bias causes charge voyage that generates an attractive electrostatic force between the two conductors[2]. It is the force relationship that leads to the phenomenon of pull-in. Pull-in refers to the fact that for two suspended conductors, such as we have been describing, a trajectory of increasing voltage bias will increasingly deform the structure to the point of contact between the conductors or to some other stable configuration such as contact with a dielectric included in the structure for just this event. Electrostatic actuation is preferred for MEMS actuators because of its numerous advantages including fast response time and ease of integration and fabrication.

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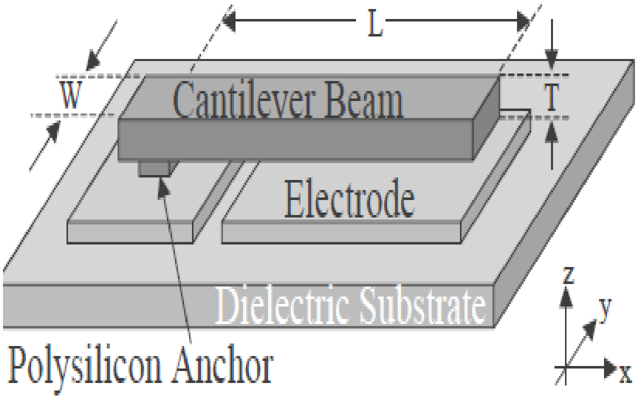

Fig.1 Cantilever Structure

II. ELECTROSTATIC ACTUATION

Electrostatic actuation makes use of electrostatic force induced by the potential difference between a microactuator and its electrode. Its applied voltage increases, higher electrostatic force results in more displacement. The both DC bias and AC signal are used to displace a microactuator at the same time. Although the dynamics of a microactuator can be linearized within small displacement, an electrostatic microactuator is essentially nonlinear, making it more difficult for feedback control to be implemented whereas achieving a large displacement. Although electrostatic actuation requires higher actuation voltage than that of other actuation methods, electrostatic actuation does not require complicated fabrication methods, piezoelectric materials or ferromagnetic materials deposited on a microactuator. The electrostatic actuators require very small current, depending on the size and geometry of microactuators. The limited operation range due to the pull-in effect, nonlinear behaviour in response to applied voltage, and high actuation voltage, electrostatic actuation is one of the most popular actuation methods because of its fast response time less than 0.1 ms, low power consumption, and the easiness of integration and testing with electrical control circuitry.

III. ELECTROSTATICALLY ACTUATED CANTILEVER BEAM

The various cantilever design through electrostatic actuatio ,is one of the most popular actuation methods for microactuators fabricated by MEMS technologies despite its high actuation voltage and limited operation range due to the pull-in phenomenon. Another advantage is that electrostatic actuators can be easily built by many fabrication methods, which are compatible with most CMOS technologies that are employed in order to manufacture modern analog and digital devices. Hence, electrostatic actuators can be packaged with control circuitry or measurement circuitry without much difficulty, allowing smaller and simpler products in various industrial applications. The simulation works cantilever beam design the recantgular beam and Π-Beam. The simulation of switches gives various displacements at various applied voltages. In the beginning when the electrostatic actuation force is applied the voltage induces between movable beam and electrode. The beam deflects or moves from its original position. The voltages values increases gradually but there is significant changes in displacement. A simulation is of an electrostatically actuated microcantilever beam is show below using COMSOL multiphysics. Figure 1 shows profile of surface electric potential and figure 2 profile of surface total displacement of z-component.

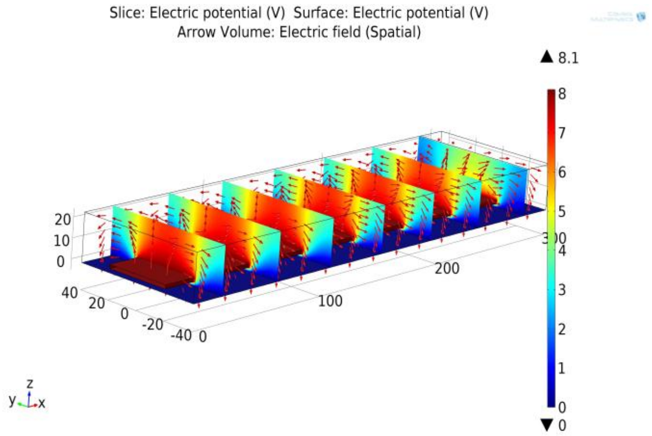

Fig.2 Electric potential of rectangular cantilever beam at 8.1 volt

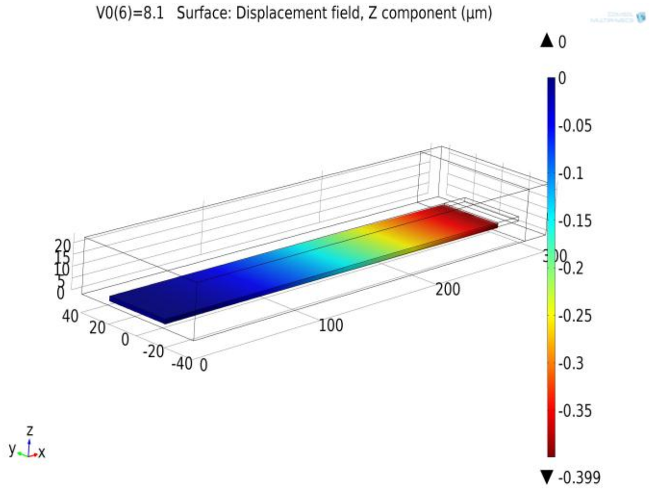

Fig.3 Simulate rectangular cantilever switch at 8.1 volt provides z-component displacement

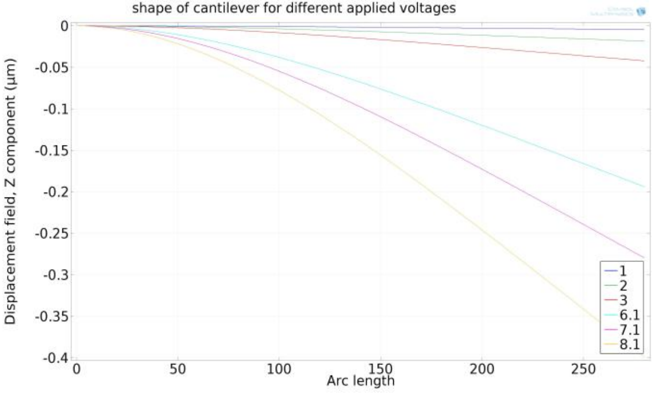

Fig.4. Graphical presentation of rectangular cantilever z-component displacement beam at various applied voltages

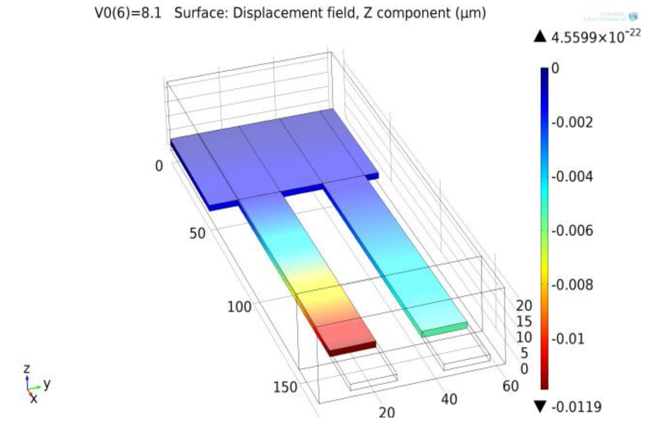

Fig..5 Simulate Π-cantilever switch at 8.1 volt provides z-component displacement

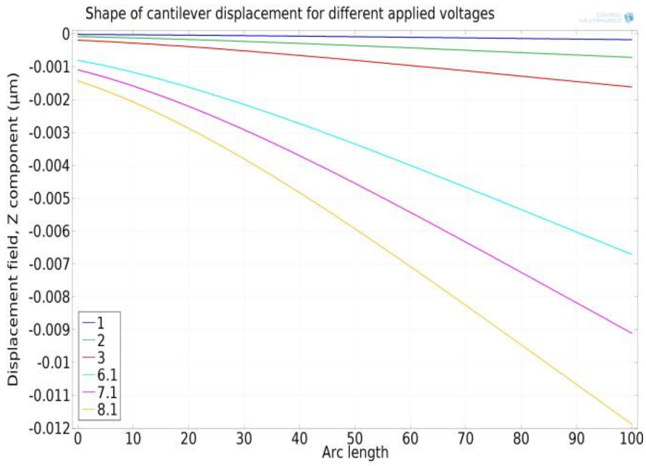

Fig..6 Graphs of Π- cantilever z-component displacement beam at various applied voltages

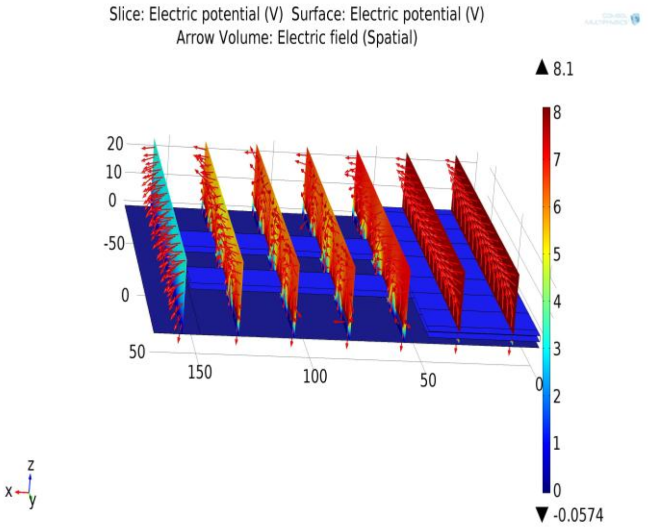

Fig.7 Pi cantilever Electric potential at 8.1 volt

Table 1 Comparison of Rectangular and Π-switch

Voltage	Rectangular Switch	Π-Switch
1	-4.5789e-3 μm	-1.798e-4μm
4	-0.0422 μm	-1.6197e-3μm
8.1	-0.399 μm	-0.0119μm

IV. RESULT & DISCUSSION

The various types design of cantilever switch represent design and simulation .The various shapes provides different z-component displacement .As Table 1 . show the comparison study of displacement at various voltages. The Rectangular gives 0.399µm at 8.1 volt. At same voltage the Π-switch will gives 0.0119 µm z-component displacement. The rectangular switch . is more flexible than to other switches .

V. CONCLUSION:

As the MEMS technology is used in the field of optical communication, wireless communication, biological sensors etc; to reduce the size of electronic devices, sensors, relay switches etc. The low actuation voltage reduced the power consumption and provides linearity of switches. The cantilever switches works on radio frequency range. In this research concluded that those switches provided maximum displacement gives high switching speed and low power consumption. The rectangular switch provided maximum displacement at applied voltage in the comparison of Π-switch.

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