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Design and Analysis of Mems Cantilever Switch

[1]Prof. Vijay Matta, [2]Ms. Sayali Dhongade,[3]Mr. Mayur Agrawal,[4]Ms. Sumita Jana,[5]Mr. Amol Bhongade
[1] Lecturer, Department of Electronics Engineering, S.B.J.T.M.R, Nagpur University, Nagpur-440017
[2], [3], [4], [5] UG Student, Department of Electronics Engineering, S.B.J.T.M.R, Nagpur University.
[1]vijumatta@gmail.com,[2]sayali@gmail.com,[3]mayuragarwal1911@gmail.com,
[4]jsumita1@gmail.com,[5]amol0906@gmail.com

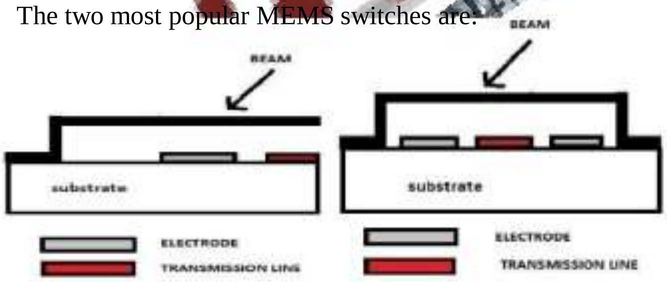
Abstract: **The intent of this paper is to discuss about the MEMS switch ,its design in an optimized way .Various aspect in which MEMS switches are advantageous over semiconductor switches are also compared in it. Mechanical coaxial and waveguide switches have low insertion loss, large off-state isolation and high power handling capabilities, but they are bulky, heavy and slow. The semiconductor switches have faster switching speed and are small in size and weight but have high insertion loss hence more static power consumption and less isolation and power handling capacity; Whereas MEMS switches have the advantages of both , the Mechanical and Semiconductor Switches .They provide higher RF performance , low static power consumption but with smaller size ,weight and is available at low cost .The MEMS switches are designed and its result are obtained by using Coventorware and this software is explained in detail in pervious paper.**

Keyword: **MEMS, MEMS switch**.

INTRODUCTION

The MEMS (micro-electro-mechanical –system) RF switches is being consider as the most important subject for research field is the last recent years .The MEMS switches are advantageous over other semiconductor switches because of its small size (dimension is in Microns) low cost ,lesser power consumption , high isolation and lower insertion loss . Thus MEMS switches are easy to integrate into system or modify, have small thermal constant can be batch fabricated on a large scale and is highly resistant The MEMS switches are used in wireless communication on a large scale to vibration shock and radiation. The outstanding performances characteristic makes the MEMS switches most important.

The two most popular MEMS switches are:



a) Cantilever Switch b) Fixed-fixed Switch

In the cantilever switch operation between the top and bottom actuation a dc voltage is applied. Because of this voltage electrostatic force is generated which will bend the cantilever toward the bottom electrode but at the particular level (i.e. the pull-in voltage) the top electrode will touch the bottom electrode which result in the closing of switch by connecting the shorting bar metal to the input and output signal RF transmission line .In the fixed-fixed beam there is fixed connection at both the ends. The electrostatic actuation between the transmission line and ground is provided by the centre electrode. When the switch is in the upstate low capacitance is provided to the ground and hence it does affect signal on the transmission line, but when the switch is in downstate the capacitance provided to the ground is higher which leads to high isolation and short circuit.

I. METHODOLOGY

In everyday life, we tend to come across a number of mechanical and semiconductor switches. These types of switches are used in many applications .A large number of these applications need a switch which has better performance in all areas, hence MEMS switch has become a necessity. As we know that there are two types of switches mechanical and semiconductor switches. Mechanical coaxial switches offers advantages of low insertion loss, large off-state isolation and high power handling capabilities .These type of switches are bulky and slow. Semiconductor switches (FET) provide faster switching speed but they have high insertion loss and inferior in static power consumption. For making any of the MEMS switches the basic step involved are the substrate layer, then materials are deposited on the substrate for transmission line and electrode, then sacrificial layer is used to stabilize the cantilever beam in the air. According to these steps, we firstly design a base that act as a substrate. Substrate is a basic layer for designing a switch. After the substrate layer, the second layer deposition will be for transmission line and electrode .Then now according to our design the portion for transmission line and electrode is masked .After that the portion which is remaining in excess is removed through etching .After the process of etching , transmission line and electrode are obtained . Then the sacrificial layer is deposited, sacrificial layer is used for stabilizing the designing i.e. it acts as a pillar for cantilever beam. After stabilizing the beam the sacrificial layer is deleted and at last we will get a well designed switch.

II. RESULT

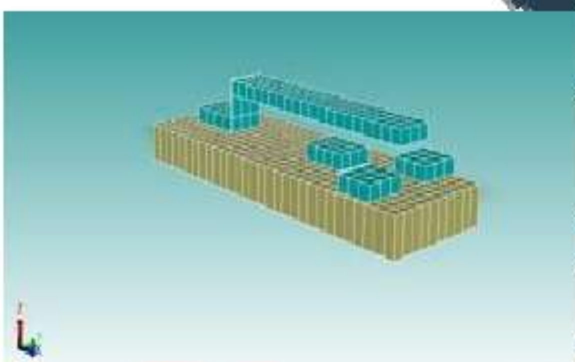


Fig 1.1 Illustration of 3D Meshed Layout

After meshing we use the Analyzer module to perform simulation in three different fields:

- MemElectro → electrostatic and electro-quasi-static
- MemMech → mechanical, thermo-mechanical and piezoelectric
- CoSolveEM → coupled electromechanical.

Length	Width	Gap	Pull In Voltage (V)	Actuation Voltage (V)
80	30	1	7	21.1
		2	13	39
		3	19	57
	40	1	5.75	17.25
		2	11.75	35.25
		3	17	51
100	30	1	4.5	13.5
		2	8.45	25.35
		3	12.25	36.75
	40	1	3.75	11.25
		2	7.5	22.5
		3	11	33
120	30	1	3.65	10.95
		2	6	18
		3	9.25	27.75
	40	1	2	6
		2	5.25	15.75
		3	8.5	25.5

Table 1.1 Coventorware Model Analyses

From the different models considered and modeled it was analyzed that as the beam length is increased the voltage required for the boundary deflection reduces, as the bottom electrode shifts from anchor towards the tip of the beam. Coventorware analysis with respect to CoSolveEM field for Pull In and Variable Voltage is as shown below:

Variable Voltage → Actuation voltage is evaluated to be 15

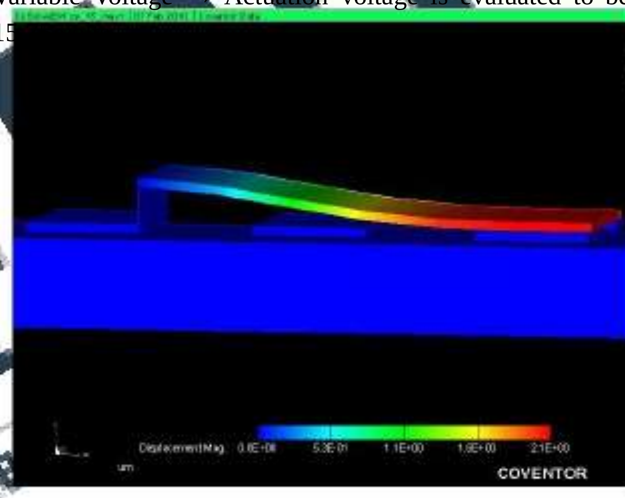
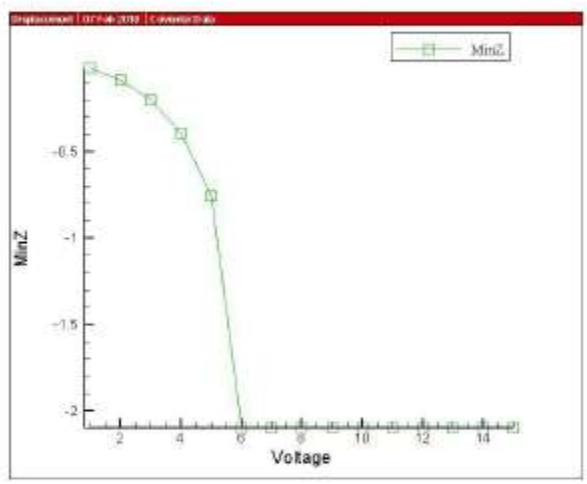


Fig1.2 : Variable Voltage Deflection (3D).



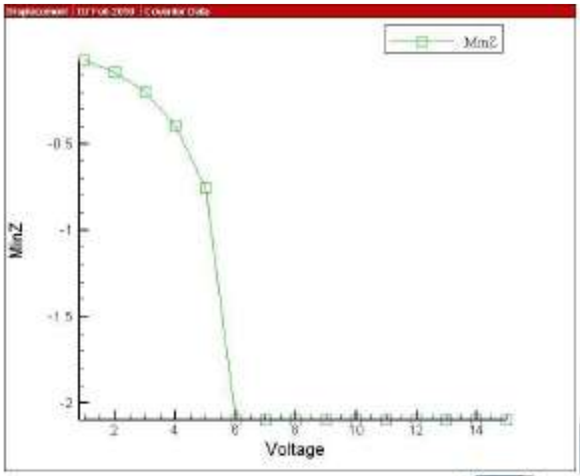


Fig: Variable Voltage Deflection (Graph).

CONCLUSION

Analytical values were validated with the best simulation design feasible for the required switch design and the actuation voltage was found out to be around 16 volts where in the beam snap down occurs and the bottom electrode comes in contact with the beam. The switch was designed with the intention of having current density in ideal range so that the deprivation mechanisms reduced as much as possible and controlled with the help of design.

FUTURE SCOPE:

Reducing more deprivation mechanisms so that best design modeled can be fabricated.

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