ANALYZING THE EFFECT OF FRINGING FIELD WITH DIFFERENT MATERIALS

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Abstract: The status of MEMS technology is reviewed with particular emphasis on materials issues therein. The materials issues in MEMS is very important thus different MEMS materials are used in this paper to analyze the effect of fringing fields like silicon, polysilicon, silver, copper and gold. Each of these materials is addressed with particular emphasis on the potential impact of fringing field. Copper produces maximum fringing effect followed by Silver, Gold, Polysilicon and Silicon.
Keywords: Fringing Field, Etching Holes, Capacitance.

I. INTRODUCTION

MEMS speak to a quickly creating region of innovation with awesome financial potential. Advances in materials science and innovation have assumed key parts in the development that has happened hitherto, and will keep on doing so in the coming decades. Close term improvements are moderately clear to gauge in connection to MEMS which are gotten from microelectronic gadgets and offer the microelectronic device set for creation. These territories for progression include: new material improvement, manufacture process headway and the advancement of standard mechanical portrayal procedures. As to new material improvement the incorporation of silicon carbide and perhaps jewel for mechanical components and the development of the arrangement of conceivable transducer materials over incredible potential for expanded execution. As to manufacture forms the proceeded with advancement of veils and engravings that can yield high angle proportion structures and the improvement of testimony systems, especially as to making thicker coatings with lessened remaining feelings of anxiety, are key exercises. The advancement of standard portrayal strategies, especially as to the mechanical properties, is imperative if the maximum capacity for paralleling the recreation based plan approach accomplished for VLSI gadgets is to be figured it out. In the more drawn out term, incredible potential exists for extending the creation apparatus set for MEMS, and unwinding the limitations forced by firmly following procedures utilized for microelectronic manufacture. Specific advances incorporate the improvement of systems for making really three-dimensional structures, while as yet taking into consideration wafer-level "multi-up" manufacture. Advances are being shown in materials science in the making of self-collecting natural materials. These materials over the guarantee of fundamentally modifying the manufacture apparatus set and the structures and materials that can be considered and in addition allowing thought of gadgets at little scales. It stays to be seen what, assuming any, part these materials play in MEMS gadgets as we presently comprehend the term. There is likewise impressive enthusiasm for supposed ``Nanotechnology" which surmises that self-collecting gadgets could be created at scales a few requests of extent beneath those right now involved by MEMS. This might be conceivable, however cautious investigation should be connected since existing MEMS are as of now at scales where execution is restricted by dissipative marvels, for example, thick stream and situation. Incomprehensibly the most critical advances in MEMS may happen by creating advances to deliver bigger gadgets with comparable unit expenses to those for existing microelectronics. These gadgets would have more helpful power and power abilities than current MEMS and are maybe more legitimately named mesoscale machines. MEMS likewise finished significant chances to propel the field of materials science at bigger scales. Micro fabricated test components empower nuclear power magnifying lens and filtering burrowing magnifying instruments that have upset surface science and tribology. Microfabricated test structures empower the estimation of properties at little scales for applications other than MEMS. MEMS sensors can likewise be utilized as screens for expansive scale forms. The improvement of MEMS gadgets to screen microstructural development amid preparing or corruption and harm amid task is additionally doable. Moreover, microscale substance and natural reactors may allow the amalgamation of novel materials because of the capacity to nearly control the conditions under which the blend happens. Key territories for materials science to center around incorporate the expansion of the accessible arrangement of materials that can be microfabricated, the refinement of the arrangement of procedures accessible to microfabricate structures, and change in the techniques used to describe and select materials for MEMS applications. In tending to these issues it is essential to do as such with regards to MEMS as frameworks, since materials arrangements are just reasonable in the event that they are perfect with the general creation course and the prerequisites for the application. MEMS technology field, the accurate determination of capacitance is an important issue because which affects the performance of capacitive devices. For example, the fringing field capacitance should be considered to exactly determine the electromechanical behavior of a curled cantilever beam. Moreover, for the semiconductor industry, the capacitance estimation of the MIM capacitor, interconnection, and MOS capacitor also affect the performance of the whole circuit. The three-dimensional fringing fields must be taken into consideration if the wires or microstructures are short. Therefore, how to fast and accurately determine the three-dimensional capacitance becomes a major task in order to improve device quality. There are several types of capacitors usually used nowadays, such as parallel-plate capacitors, MIM capacitors, comb capacitor etc. Among the aforesaid kinds of capacitors, parallel-plate capacitor can be regarded as a typical and basic model of capacitor. However, most parallel plate capacitance models lead to very large errors due to the rapid size-shrink of devices encountered in the present day. Thus, analyzing the characteristics of a parallel-plate capacitor with fringing field effect is essential.

II. PROBLEM STATEMENT

Microelectromechanical systems (MEMS) have recently become an important area of technology, building on the success of the microelectronics industry over the past 50 years. MEMS combine mechanical and electrical function in devices at very small scales. Examples include pressure sensors, accelerometers and gyroscopes. In each of device electrostatic places a very important role. The electrostatic force is a function of how the capacitance between the teeth changes with respect to their relative vertical positions. Traditionally, a poor estimate of the capacitance, that does not include the fringe electric fields around the tops and bottoms of the comb teeth, has been used to calculate electrostatic forces. Formula to calculate the capacitance of a capacitor only gives us the value due to direct fields only. But there also exist a field on the edges of the capacitive devices called as fringing field. In this paper we proposed a more accurate model to compute the effect fringing field on capacitance. Fringing is the bending of the electric flux lines near the edge of the parallel plate capacitors. Fringing is also known as " edge effect ". Normally the flux lines inside the capacitor are uniform and parallel. But at the edges, the flux lines are not straight and bend slightly upward due to the geometry. This is known as fringing effect. In this paper the current status of MEMS fringing field capacitor is reviewed with a particular emphasis on the role of materials.

III. MOTIVATION

MEMSalso offer the opportunity to materials scientists and engineers to be able to characterize materials in ways that have not hitherto been possible. In this thesis the current status of MEMS fringing field capacitor is reviewed with a particular emphasis on the role of materials, as well as some of the opportunities for MEMS to contribute to the wider field of materials science and engineering Transduction in micro electromechanical systems (MEMS) or nano electromechanical systems (NEMS) is mainly based on electrostatic excitation. Electrostatics forces in these devices are found on the approximation of parallel plate capacitance with or without fringing effects. As the dimension of the devices reduces from micro to nano scale, the fringing effect plays an important role. The accuracy of the fringing force effects become even more important when an array of micro/nano beams operate in a cluster. This is very important effect to study and to analyzed in research.

IV. RESULT

Microelectromechanical systems (MEMS) have recently become an important area of technology, building on the success of the microelectronics industry over the past 50 years. MEMS combine mechanical and electrical function in devices at very small scales. Examples include pressure sensors, accelerometers, gyroscopes and optical devices, as well as chemical, biomedical and fluidic applications. The status of MEMS technology is reviewed with particular emphasis on materials issues therein. The materials issues in MEMS is very important thus different MEMS materials are used in this paper to analyze the effect of fringing fields like silicon, polysilicon, silver, copper and gold. Each of these materials is addressed with particular emphasis on the potential impact of fringing field.

A typical capacitor consists of 2 conductive objects with a dielectric in between them. Applying the voltage difference between the plates result in electric field. This field exists not simply directly between the conductive objects, however extends a long way away, a development called a fringing field. To accurately predict the capacitance of a condenser, the domain wont to disc the fringing field should be sufficiently massive, and therefore the acceptable boundary conditions should be used. This instance discs a parallel plate capacitor in air and studies the dimensions of the air domain. The selection of condition is additionally self-addressed.

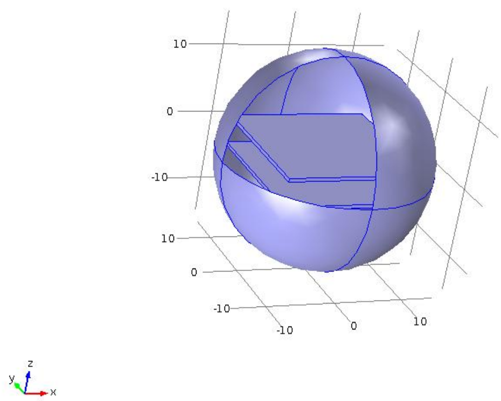

Figure 1: Final Disc Geometry.

1. Silicon

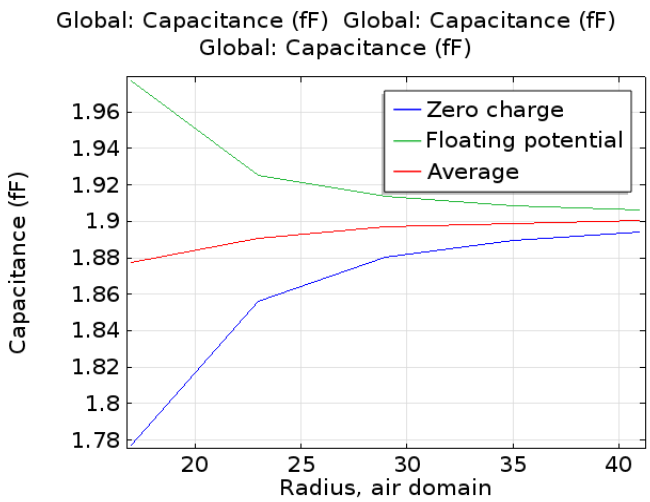

Figure 1: Capacitance of Rectangular disc with silicon.

The capacitance for the floating potential is larger than the 1.96 fF and the zero charge capacitance is less than 1.78fFand the average value of the two is given by 1.88 fF for the rectangular disc with 2 μm gap and silicon as base material.

2. Polysilicon

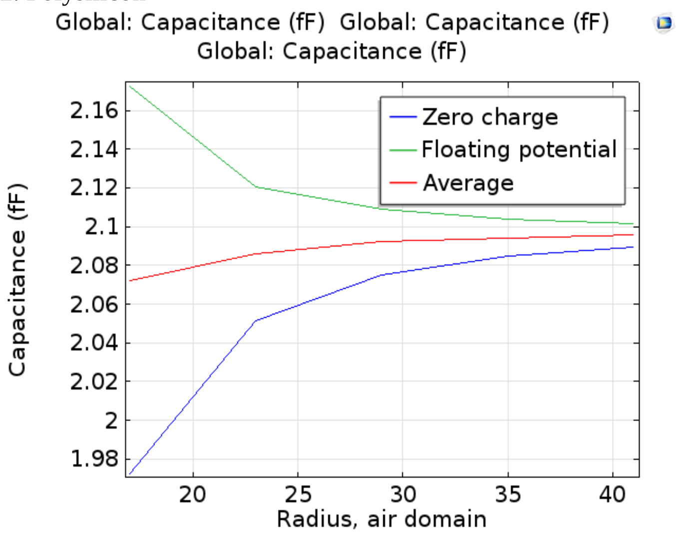

Figure 2: Capacitance of Rectangular disc with polysilicon.

The capacitance for the floating potential is larger than the 2.16 fF and the zero charge capacitance is less than 1.98 fF and the average value of the two is given by 2.08 fF for the rectangular disc with 2 μm gap and polysilicon as base material.

3. Silver

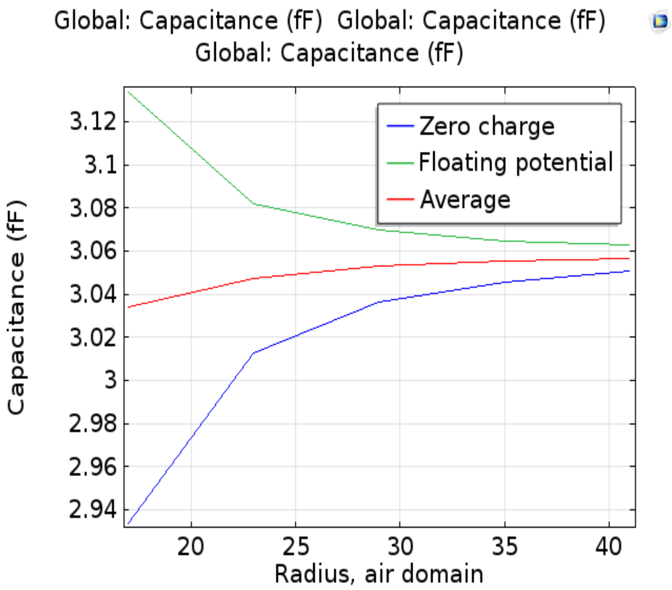

Figure 3: Capacitance of Rectangular disc with silver.

The capacitance for the floating potential is larger than the 3.12 fF and the zero charge capacitance is less than 2.94 fF and the average value of the two is given by 3.04 fF for the rectangular disc with 2 μm gap and silver as base material.

4. Gold

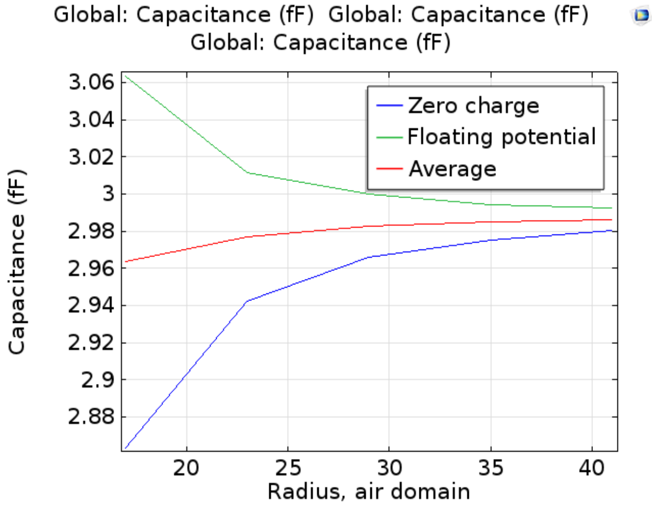

Figure 4: Capacitance of Rectangular disc with gold.

The capacitance for the floating potential is larger than the 3.06 fF and the zero charge capacitance is less than 2.88 fF and the average value of the two is given by 2.96 fF for the rectangular disc with 2 μm gap and gold as base material.

5. Copper

The capacitance for the floating potential is larger than the 3.1 fF and the zero charge capacitance is less than 2.92 fF and the average value of the two is given by 3.02 fF for the rectangular disc with 2 μm gap and copper as base material.

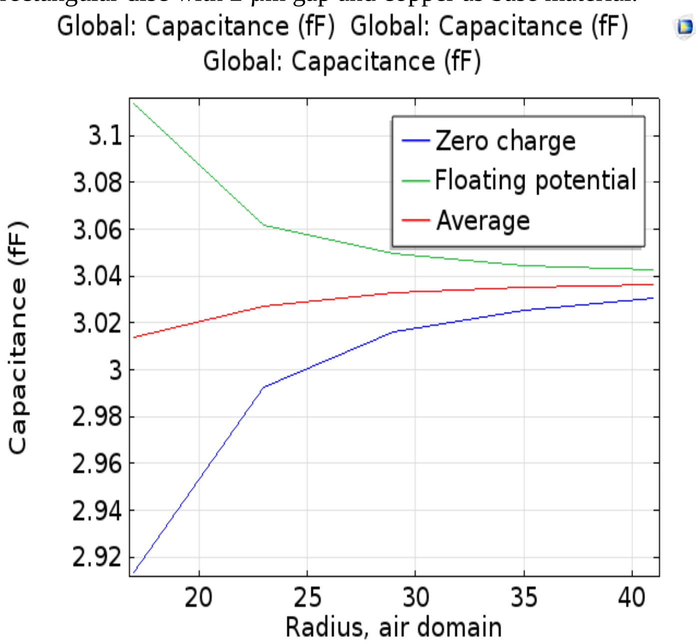

Figure 5: Capacitance of Rectangular disc with copper.

V. CONCLUSION

The electric field distribution produced by any disposition of insulating and conducting materials is a key aspect in electrical design, but exact values can only be obtained in simple geometries. In this work, using commercially available F.E.M. software we show the influence of the fringing field on the electric field distribution of a two parallel rectangular plates of different materials, system surrounded by an insulating medium taking into account the thickness of the conducting plates. We compare our results with previous published works. Finally, we obtain the relationship between capacitance and insulation characteristics, with different materials. Greater the conductivity greater is the fringing field. Copper produces maximum fringing effect followed by Silver, Gold, Polysilicon and Silicon.

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