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Research paper

Cantillever based MEMS pressure sensor

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Abstract

Objective: We are analyzing the different piezoelectric materials which are best sutable combination for the design of pressure sensors used for the production of voltage.Our main theme is to find which combination gives high voltage.
Methods: We are incorporating different layers on the cantilever beam such as piezoelectric material (PZT,$BaTiO_3$), electrode(Pt,Al), insulator(Si_3N_4) on siliconwafer(SiO_2). We had used these materials for MEMS pressure sensor utilizing diverse [different] Piezoelectric materials The relative study by simulation can be utilized to give the rules to a configuration and streamlining of execution of the distinctive piezoelectric micro cantilever pressure sensors.
Findings:.We have designed, displayed and simulated our module in COMSOL software taking into account limited component strategy [FEM]. The structure made up of silicon on piezoelectric micro cantilever with cantilever beam. In reenactment [simulation] we have concentrated on varying so as to displacement and voltage connected pressure. It is observed that the induced voltage is practically straight [linear] with the applied force
Improvement:From this design we analysed that at particular dimensions of materialswithcombinationofPZTand Al gives best voltage than remaining combinations like PZT and Pt.

Keywords:*Cantilever beam, MEMS [micro electro mechanical systems], Piezoelectric materials, Pressure based Sensor, Finite Element method [FEM].*

1. Introduction

The MEMS engineering [Micro Electro mechanical Systems] need pulled done various examiners since late decades especially in micro sensors Furthermore actuators. Previously, MEMS weight sensors need aid a standout amongst the vital sensors around them. These weight sensors have been depended once different physical properties in piezoresistive, electric, capacitive. However, as Compared will different MEMS advances, piezoelectric MEMS prescribe uncommon prizes1. Smits Furthermore Choi introduced electromechanical trademark of a heterogeneous piezoelectric binge relies once different electrical Furthermore mechanical (physical) limit conditions: A mechanical minute to the conclusion of the bender, An weight associated inverse of the tip of the binge Also a uniform load associated again the entirety period of the binge. Zhang and Sun2 portrayed the association between minimum observable energy inclinations Furthermore level estimations clinched alongside noncontact examining energy microscopy using piezoelectric micro cantilever.
FEA [finite component analysis] the usage of COMSOL Multiphysics carry been utilized within this fill in to interrupt down those outcomes of the multi-layer cantilever structures using piezoelectric materials (PZT, BaTio3, Zns). That configuration of a shape is used already, made SiO2-based cantilevers3. using this structure those features from claiming piezoelectric material want been depicted or placed. those re-enactment comes about display the ones uprooting furthermore electric powered potential are incremented particularly Likewise joined weight additions. on this work, correlations from claiming re-enactment from claiming extraordinary piezoelectric materials (PZT, BaTiO3 and ZnS) have been completed the use of equal structure. The to be had setup what is more operational measures would cartoon out on this paper.

2. Theory

"Piezoelectricity" is clarified as the potential of specific materials to create electrical rate due to mechanical deformation. There are not any sure popular strategies for to compute the electromechanical piezoelectric parameters. records approximately the layers in multilayer cantilever is regarded in table14.
on this design, two specific methodologies are determined the elements of the multi-layer cantilevers beam. The most important method clarifies theoretical dating among surface stress (strain) and tip elimination at the upper layer of the micro cantilever and the evaluation among the piezoelectric tip displacement and the affected stage voltage is cleared. Piezoelectric materials deform then electric charge totals on repudiating surfaces and makes a voltage whilst strained by using an out of doors force5. that is a right away result of the immutable (perpetual) dipole nature of those materials. right while differential floor tension is at the top layer of the cantilever, the tip displacement (z) finished with the aid of the differential floor pressure(s) may be made as.

$$Z = \frac{3(1-v)l}{t\hat{}2e}\Delta s \quad (1)$$

Here l is the cantilever length, t is the thickness of cantileve, v is the Poisson proportion, ΔS is the differential surface area of the stress (pressure), and e is the Young's modulus.

When the pressure applied on the cantilever beam and the beam displaces from that force. Due to this the voltage is generated and it is calculated from the given equation 2.

$$V = \frac{t^2 e_e}{3dl^2 \varepsilon_p} Z \quad (2)$$

Revising the comparision (2) utilizing the mathematical statement (1) and composed as equation 3.

$$V = \frac{e_e(1-\nu)}{de_p \in} \Delta S \quad (3)$$

Here*V* is the voltage created or connected from the piezoelectric substrate, Young's modulus e_p(piezoelectric material), e_e is the Young's modulus of elasticity elastic materials and d is the piezoelectric consistent of the piezo electric –material which we are using.

In the second technique, FEM[6](Finite Element Method recreations or simulation) utilizing COMSOL with solid mechanics and electric resistance have been executed on multi-layer cantilevers[7].

3. Design and simulation

Inside the present take a look at our predominant intension is to find FEA [finite element analysis] COMSOL Multiphysics program is used for simulation of our shape. COMSOL software program device is a limited component analyzer, solver and Simulation programming software. This FEA [finite element analysis] software has bundles for distinctive cloth of science and physics designing programs. This FEA[Finite element analysis] software has a MEMS bundle. shape 1 has platinum (Pt) fabric as anode and in shape 2 has aluminum (Al) steel as anode terminal. Measurements and fabric of structure 1,2 has been displayed in desk 2, 3. Structure2 aspect image of the layout has been seemed in figure 1 and parent 2 shows the 3-d view of the layout in COMSOL software. on this re-enactment(simulation) we've got few assumptions as follow

1. every and every piezoelectric layer have starting now been captivated(polarized) and the voltage received may not alternate the polarization fabric.
2. The cantilever bendy stop is depicted because the starting place of the X-bearing. this is except sturdy with the cutoff situations three. Settled primary is made in Y-Z bearings at inception aspect.
4. every one of the houses of materials are taken as default residences of era (reproduction) programming on this reenactment (simulation) we've some assumptions. these are taking after presumption.

Fig 1.Shows Different layers side view of the our layout inside the software for second view.

Fig 2.Shows 3D view of multilayer cantilever beam in COMSOL software

4. Results and discussion

Reproduction about this fill in would done Eventually Tom's perusing piezoelectric gadgets8 (materials) model about COMSOL Multiphysics. This propagation cost (simulation) investigations each a standout amongst the parameters distinguished for piezoelectric materials. Piezoelectric more diminutive scale (micro) cantilever structure may be produced using 3d robust parts. That structure will be squashed which comprises from claiming 50,000 will 90,000 segments. Stationary sort investigation may be concluded for Recreation outcomes. Firstly Recreation outcomes are accomplished for structure 1(table2). Surface weight (N/m2) is set in X What's more Y heading What's more twisting for multilayer cantilever will be along On Z course. That relocation of particular case conclusion multilayer cantilever will be particularly relative on joined surface pressure, scientific comparison (1).

Figure 3 gives the information of the displacement when we applied the load the tip of the cantilever beam of the flexible end has the maximum displacement up to (3.8um) other end is fixed. Mainly we had observed that displacement changes with respect to the applied pressure in a linear manner.Figure4shows that it is arc length graph and from that we can say that displacement increasing with respect to the length of the cantilever beam when 5(Nm^2) pressure applied.

Figure 5, 6shows the linear increment of displacement and electric potential[9]with respect to the applied pressure 5N/m^2. From above simulated results it knows that structure2 giving best results compared to structure1. Pt (platinum) act like as an electrode in the structure1 and in the structure2 have Al (aluminum) as an electrode. Compared to the platinum (Pt) with aluminum (Al), aluminumhave low values of Poisson ratio and Young's modulus.

From the Figure7, we abtained that Zinc sulfide having better displacement compared to barium titanate. In the Figure7 series1 for Zinc sulfide and series-2 give the information about Barium titanate, the below graph is showing that increment of displacement with respect to applied pressure increases.

5. Conclusion

In this paper we mentioned about piezo electric materials[PZT,Batio3,Zns] and how the properties of the material effecting to pressure sensor application. In the COMSOL software we had designed the structure which is having multi layers and the multi layers we used the different piezo materials by using the FEA [finite element analysis] and based on the simulation results among the three piezo materials as above mentioned [PZT,Batio3,Zns],PZT is giving best results like more displacement and electric potential. Coming to the electrodes Al and Pt, AL is giving the best results compare to the Pt the values of Poisson ratio and Young modulus is very less. From this analysis we observed that electric potential range is (1-10) mv and by getting from this combination of Al (aluminum) and PZT (lead zirconium titanate) and while other combinations structures were not able to get above

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