MSA PROJECT REPORT

MEMS BASED GLUCOSE SENSOR

GROUP -07

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Introduction :

- Diabetes, characterized by an abnormal blood glucose concentration, is a metabolic disease that has been plaguing the human race worldwide in recent years, and the number of detected diseases are continuously growing.
- While a cure for this disease is not yet available, monitoring of the blood glucose levels can aid in minimizing the risk of contracting the disease or the chances of developing disease-related complications for those already diagnosed.
- Bio-MEMS allows for the development of devices, which are high performance, low power consuming and have high accuracy in response and sensitivity for low inputs.
- By using MEMS-based sensors, with different detection techniques, that function based on glucose affinity binding, more accurate results can be obtained.

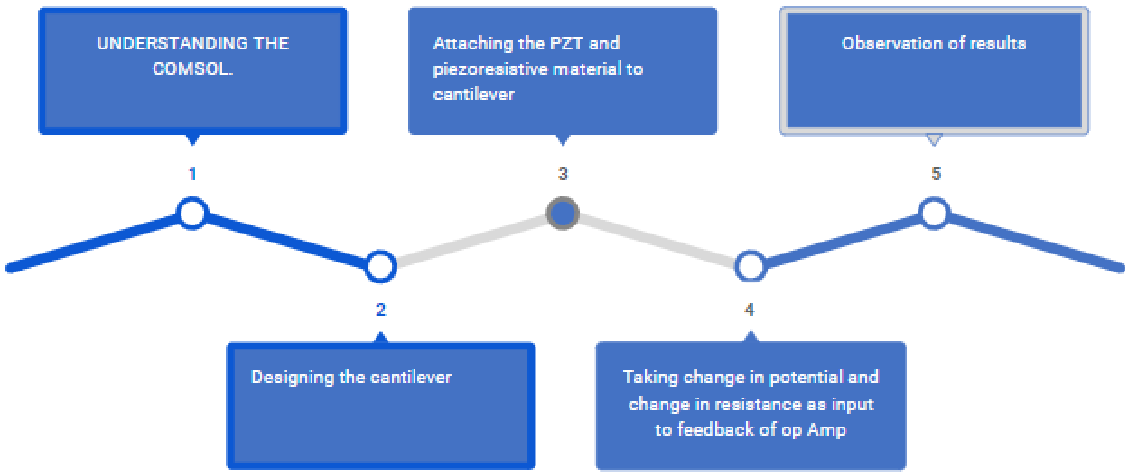
Problem statement :

To propose a blood glucose measurement sensor using a MEMS-based twin cantilever structure, which is highly reliable and accurate.Here we are designing two identical microcantilever beams featuring a dimension of 300μm x 10 μm, were designed and fabricated using the comsol software.The thickness of rigid structure is 30 μm.

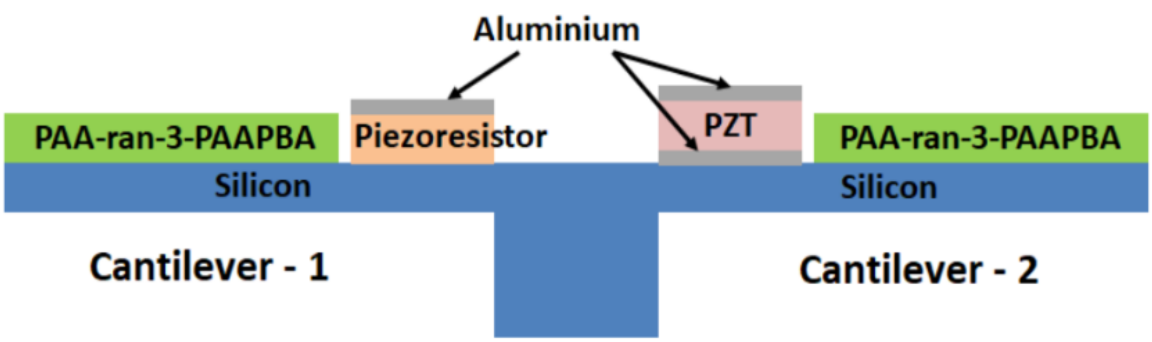
Motivation :

Close monitoring of daily physiological glucose levels reduces the risk of complications caused by conditions such as hypoglycemia or hyperglycemia.This is generally achieved by continuous glucose monitoring (CGM) systems, which involve either non-invasive or minimally invasive detection of glucose.In this project we are going to simulate the MEMS based blood glucose sensor.

Workflow :



Process flow :

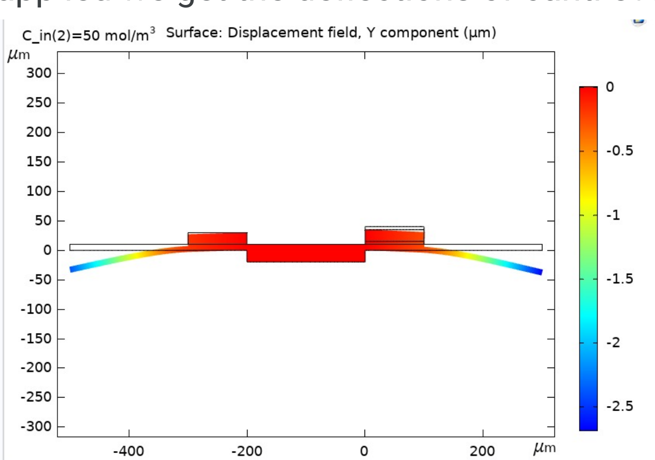


This is the proposed model diagram of the twin cantilever structure.

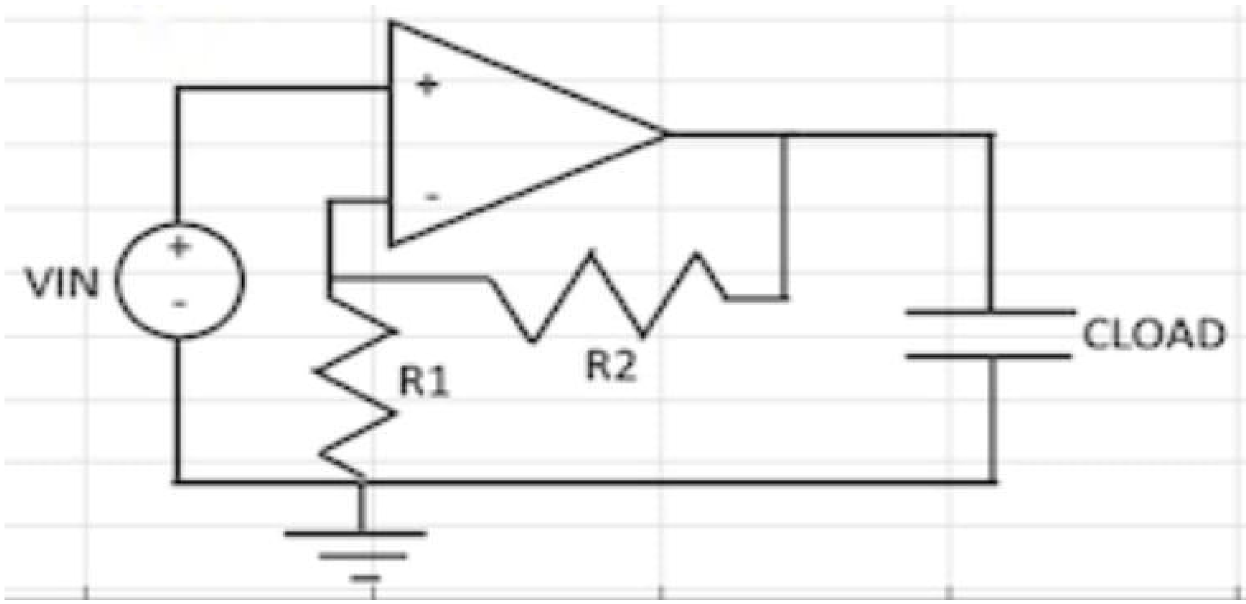
Step 1 : Designing the two cantilevers and applying the piezoresistive and piezoelectric materials

- We are applying glucose on the two cantilevers

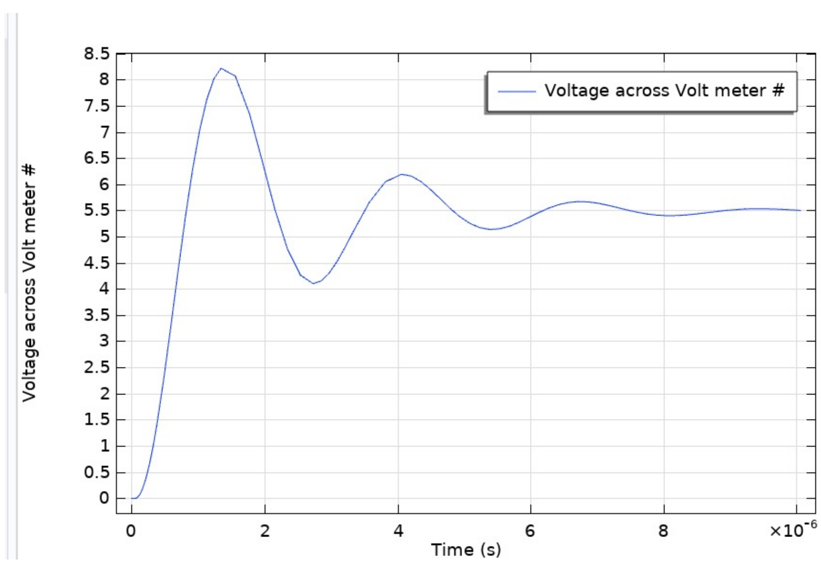
Step 2 : Applying the glucose on either side of the cantilever i.e piezoresistive and piezoelectric cantilever.Here we can observe the deflections in the cantilever due to concentration of the glucose with reference to the physics applied we get the deflections of cantilever as shown in the figure.



<u>Step 3 :</u> ***<u>OP AMP Implementation:</u>*** Taking the outputs of the piezoelectric and piezoresistive cantilever and giving it as inputs to the operational amplifier.

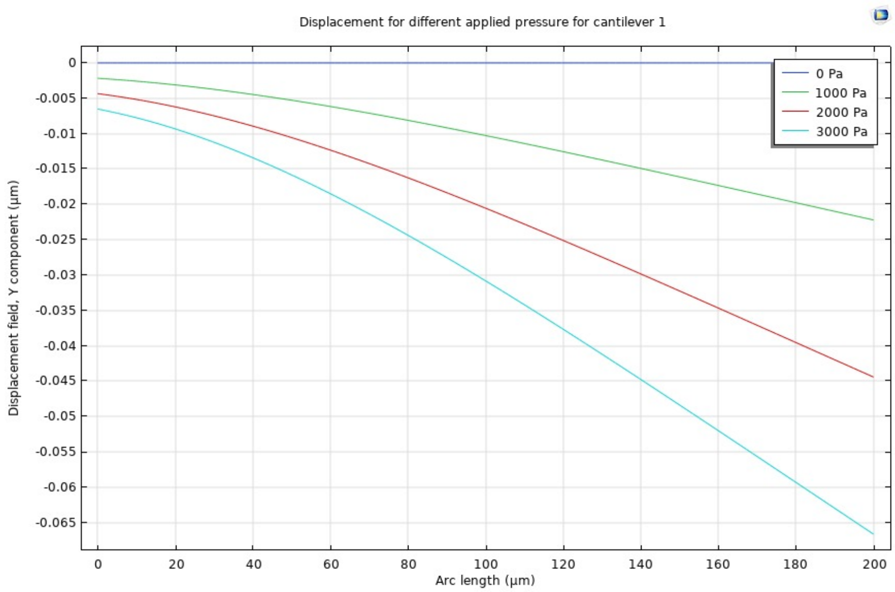


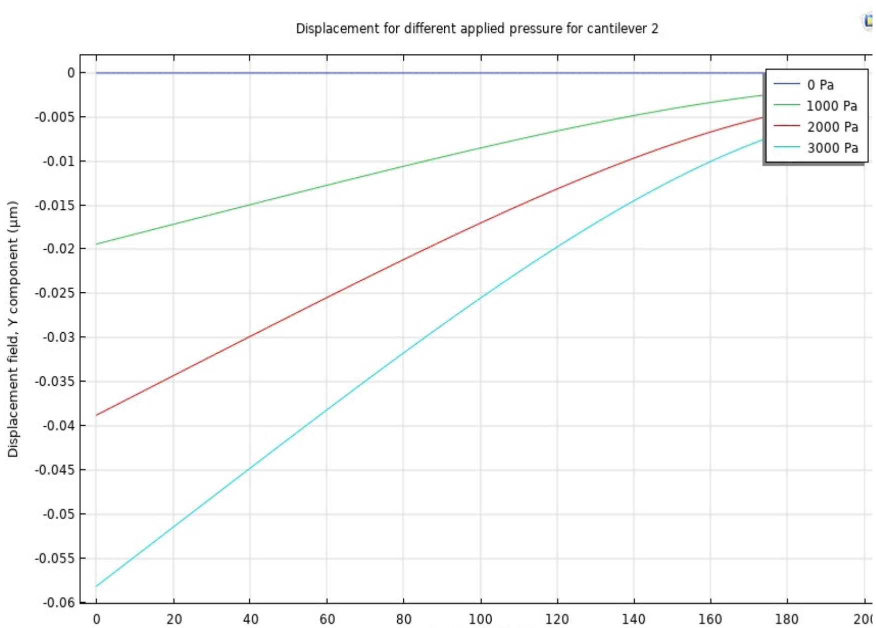
We use an AC/DC module to model opamp and the transient response is observed separately.



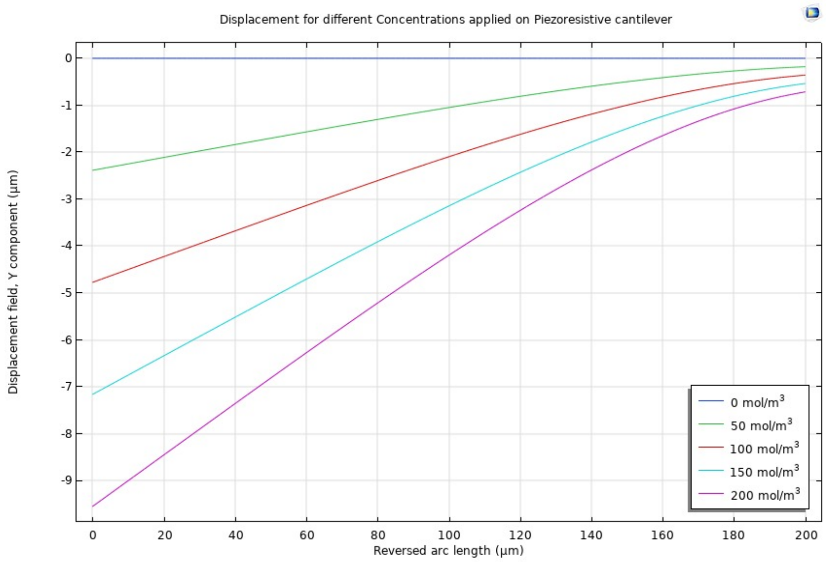
Step 4 : Observing the results

Brief results and explanation :

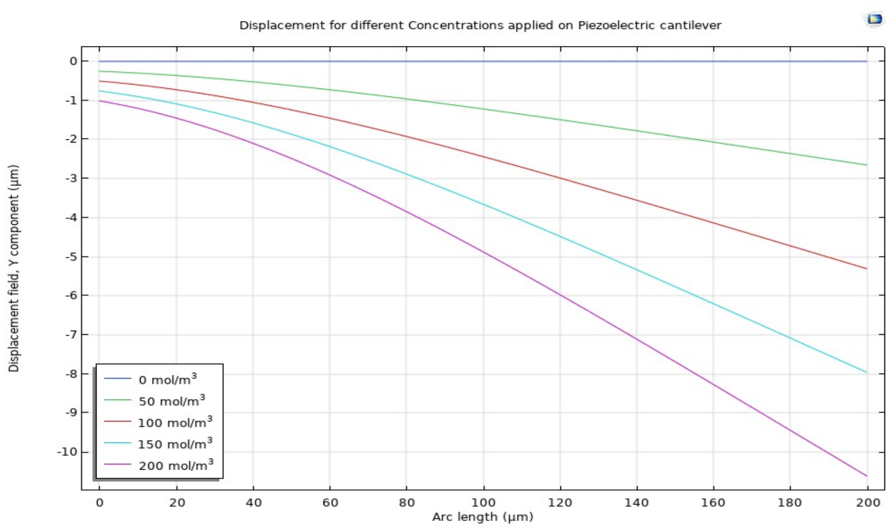




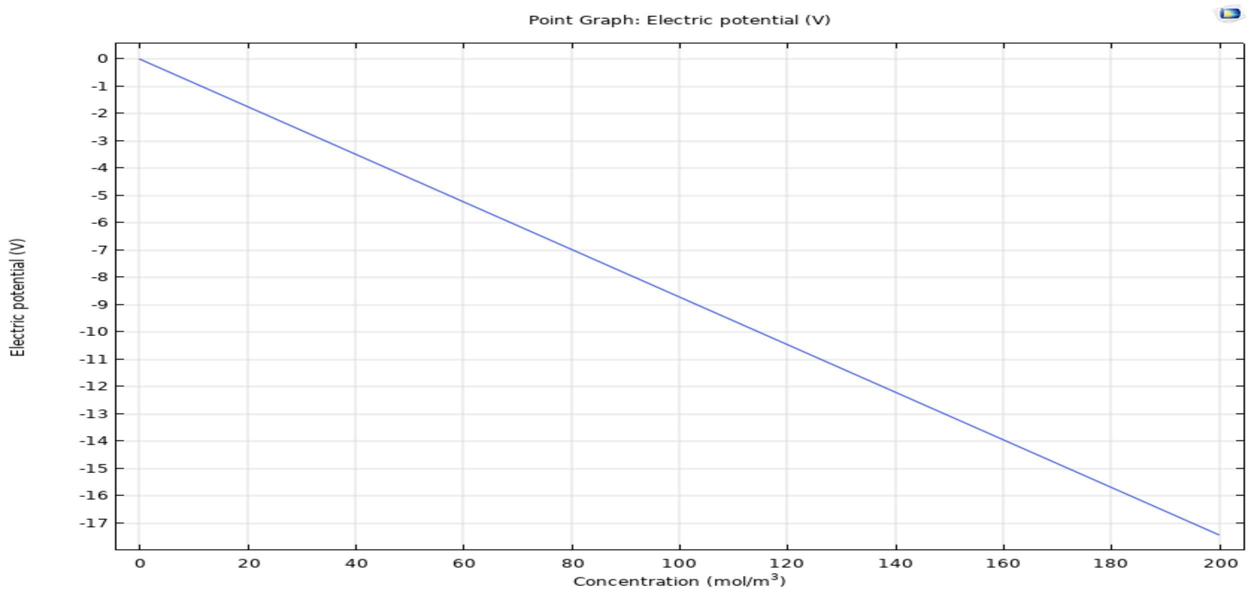
- These are the graphs for different pressure applied on the two cantilevers vs deflection in the cantilevers.
- Boundary load brings some change in cantilever deflections generally and same is observed here



- This is the graph between displacement for different concentrations applied on piezoresistive cantilever



- This is the graph between displacement for different concentrations applied on piezoelectric cantilever.
- It is due to pressure applied by glucose on free end



Plot for concentration vs Electric potential

- Voltage is increasing with increasing concentrations of glucose
- It is because when pressure is applied on piezoelectric cantilever we see that change in potential will be observed due to PZT(piezoelectric material) which converts mechanical energy to change in potential .

Conclusion :

- We have designed a MEMS bio-sensor for measuring glucose that has a simple structure compared to existing.
- From the results, we have obtained this method is efficient for sensing glucose.
- It is a cost effective way for glucose sensing, as manufacturing of this device is ease of effort.

Contribution :

KRISHNA KANTH SRIVATSAVA M - Piezoelectric cantilever
PRUDHVI RAJ CH - Piezoresistive cantilever
VENKATA SIVA T - Designing Op-Amp ,results extraction and comparison
BANU THEJA V - Designing Op-Amp ,results extraction and comparison

References :

- Ropmay, Gaddiella & Peesapati, Rangababu & Akhtar, Jamil & Kumar, Shashi & Rathore, Pradeep. (2020). A MEMS based blood glucose measurement sensor using twin-cantilever structure A MEMS based Blood Glucose Measurement Sensor Using Twin-Cantilever Structure. AIP Conference Proceedings. 2294. 10.1063/5.0031309.

- J. D. Newman and A. P. F. Turner, “Home blood glucose biosensors a commercial perspective,” Biosensors and Bioelectronics20, 2435-2453 (200)

- Huang, Xian et al. “A MEMS affinity glucose sensor using a biocompatible glucose-responsive polymer.” *Sensors and actuators. B, Chemical* vol. 140,2 (2009): 603-609. doi:10.1016/j.snb.2009.04.065