DESIGN AND SIMULATION OF PIEZORESISTIVE PRESSURE SENSOR FOR MEDICAL APPLICATION

BY:

CHANDEL SHIVANGI (23MTS0002)

D. LALITHA PRASANNA (23MTS0013)

OBJECTIVE

- To design and simulate the piezoresistive based pressure sensor using COMSOL software.
- To design the piezoresistive pressure sensor for pulse monitoring application.

EXPECTED OUTCOMES

- Potential to advance wearable health technologies by providing a reliable, convenient solution for non-invasive pulse monitoring.
- It is a wearable device where we can attach to the wrist that can help to monitor pulse of the patient continuously with out any issues.
- Accurate measurement of the pulse with applying less pressure than required.

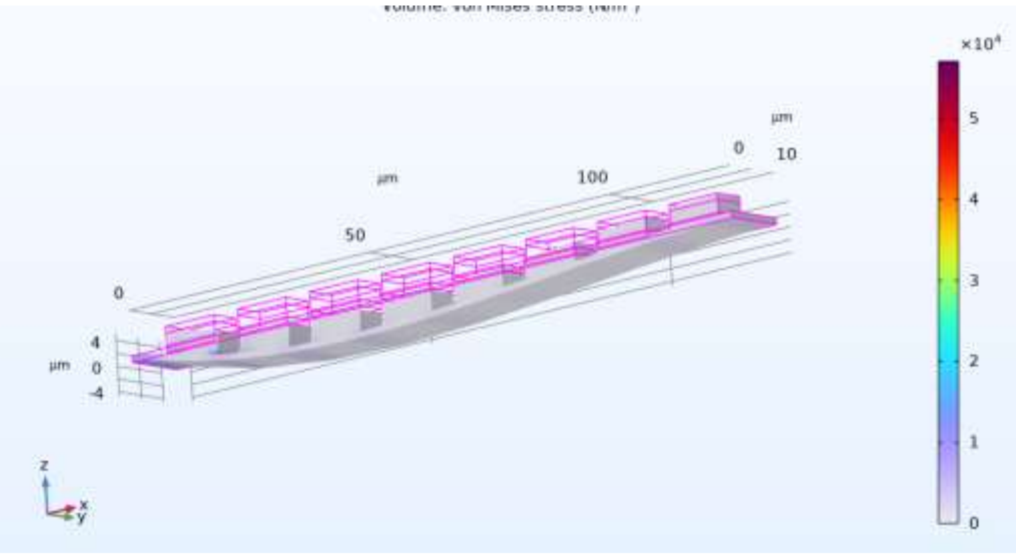
PRINCIPLE OF OPERATION OF THE SENSOR

- The piezoresistive pressure sensor operates on the principle of piezoresistivity, where the sensor's electrical resistance changes in response to applied pressure.
- Pulse monitoring uses a piezoresistive sensor integrated into wearable devices or medical equipment. It detects blood pressure variations, converting electrical resistance into a pulse-related signal. This real-time monitoring aids medical diagnostics and fitness tracking, providing vital information.

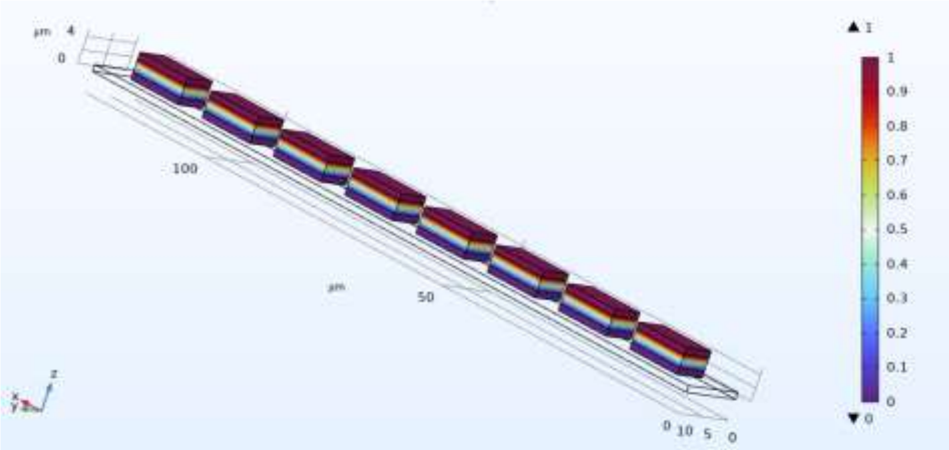
METHODOLOGY

- A piezoresistive pressure sensor for medical applications will be simulated using the selected program, such as COMSOL.
- Boundary conditions like pressure load will be imposed, and the sensor's geometry and materials (such as piezoresistors and silicon diaphragm) will be specified.
- To assess sensor performance, simulation will be used to examine stress distribution, strain gauge resistance variations, and other important factors.
- Through the use of simulation, several design possibilities can be explored and optimized prior to actual manufacture.

ANALYSIS



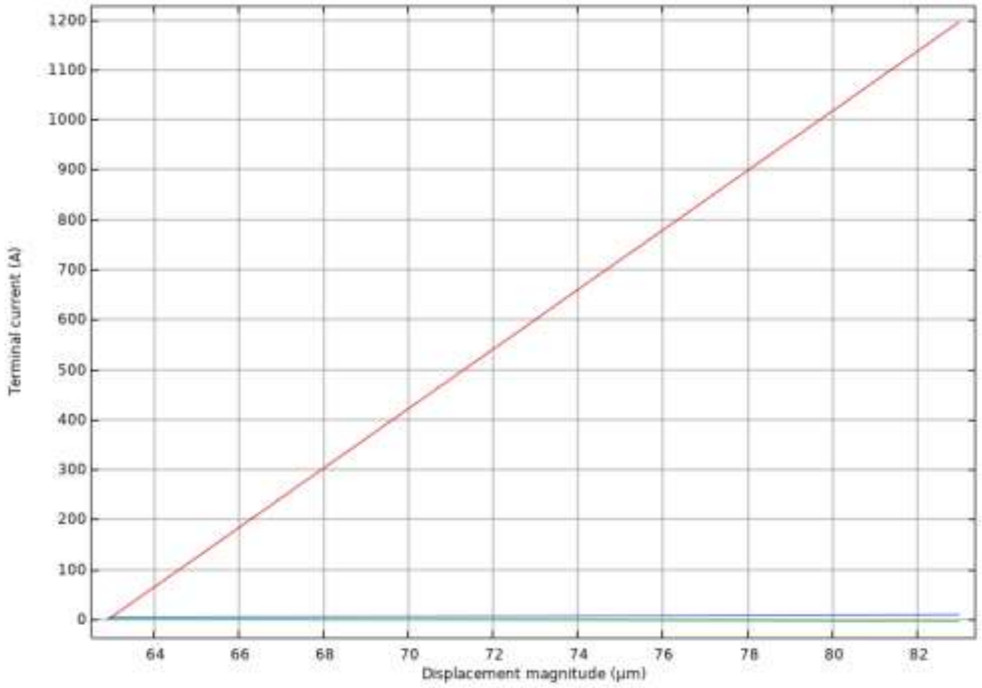
- Stress analysis when 100pa pressure applied on the electrodes



- Electric potential of the sensor

RESULT

- The graph shows a relationship between displacement magnitude and terminal current in a sensor, with a limit of 83μm when the pressure applied on the sensor for 100pa we are getting the stress of 722.44 N/m^2.



Current Vs Displacement plot

CONCLUSION

- The design and simulation of piezoresistive pressure sensors for pulse monitoring in COMSOL can lead to the development of accurate biomedical devices.
- Engineers can optimize sensor performance, sensitivity, and durability, enabling precise monitoring of pulse waveforms for medical applications.
- This approach holds potential in advancing healthcare technologies, enabling non-invasive, continuous monitoring of vital signs with improved precision and efficiency.

REFERENCES

- Xu, T., Wang, H., Xia, Y., Zhao, Z., Huang, M., Wang, J., Zhao, L., Zhao, Y., & Jiang, Z. (Year). Piezoresistive pressure sensor with high sensitivity for medical application using peninsula-island structure. DOI: 10.1007/s11465-017-0447-9
- C. Pramanik & H. Saha (2006) Low Pressure Piezoresistive Sensors for Medical Electronics Applications, Materials and Manufacturing Processes, 21:3, 233-238, DOI: 10.1080/10426910500464446
- Gao, L., Zhu, C., Li, L., Zhang, C., Liu, J., Yu, H.-D., & Huang, W. (2019). All Paper-Based Flexible and Wearable Piezoresistive Pressure Sensor. *ACS Applied Materials & Interfaces, 11*(28), 25034-25042. DOI: 10.1021/acsami.9b07465
- Jiang, H., Zhang, Y., Zhou, R., Meng, L., Chen, T., Mai, W., & Pan, C. (2020). Recent advances of wearable and flexible piezoresistivity pressure sensor devices and its future prospects. *Journal of Materials Science & Technology*, *42*, 207–220. https://doi.org/10.1016/j.jmat.2020.01.009

THANK YOU