Alternate Glucometer Bio-sensor Model based on Ultrasonic MEMS Transceivers

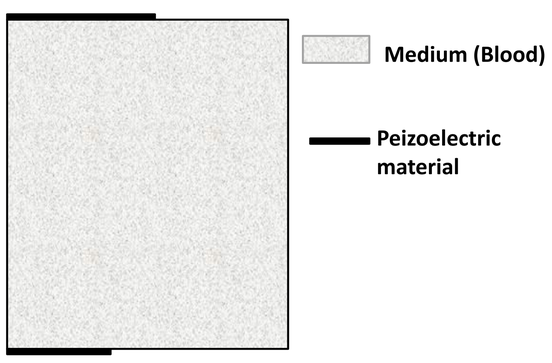
P. Pattnaik[1], S. K. Kamilla[1]*, D. P. Das [2]

1. Semiconductor Research Lab, Institute of Technical Education & Research (ITER), Siksha 'O' Anushandhan University, Bhubaneswar-751030, Odisha, India,
2. Process Engineering and Instrumentation Cell, Institute of Minerals and Materials Technology (IMMT), Bhubaneswar, Odisha,India.

Introduction:

- **To prevent complications in diabetes, accurate monitoring and timely management of blood glucose levels is essential.**
- **Regular monitoring of sugar level in patient can alarm any unwanted rise in the level and necessary precautions can be taken at the right time [1].**
- **Using an ultrasonic transceiver glucometers, continuously monitoring the sugar level of human blood, which is a non-invasive and miniaturized structures.**
- **The ultrasonic Micro-Electronics Mechanical Systems (MEMS) device was designed with lead free piezoelectric material like Barium Titanate (BaTiO3) (BT) which is capable of being used as thin film [2].**

Model geometry of ultrasonic trance-receiver:



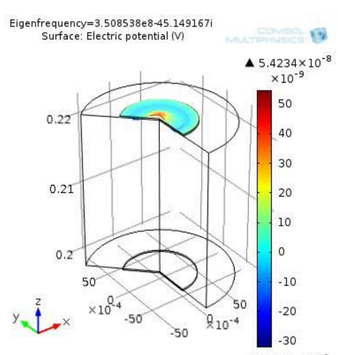


Figure 1. (a) 2D axis- symmetric geometry structure with piezoelectric material and blood medium (b) simulating 3D model using COMSOL. [3]

- **The potential of 1.6 Volts was applied to the transmitting device.**
- **The optimized device thickness and width at fundamental frequency 2 MHz was considered at 0.275 mm and 0.25mm respectively.**

Result and Discussion:

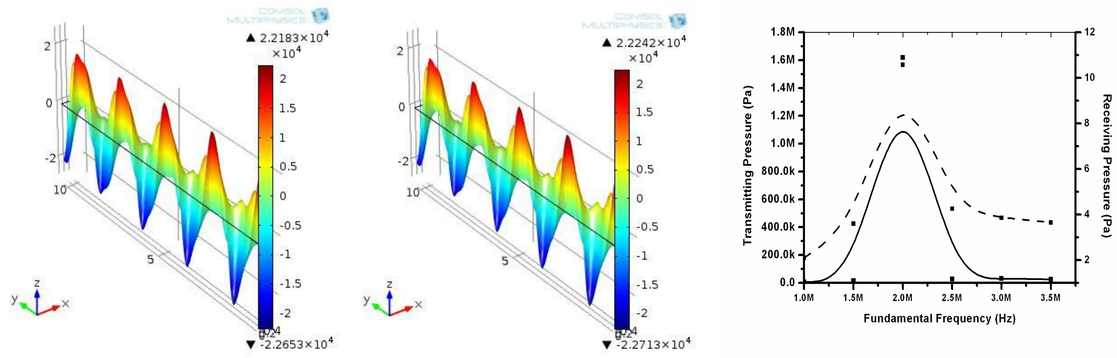


Figure 2. Acoustic pressure plots using BATiO3 based devices (a) pure blood sample, (b) blood sample (glucose added 269 mg/dL)

Figure 3. Frequency vs. pressure graph to obtain optimized frequency for BT

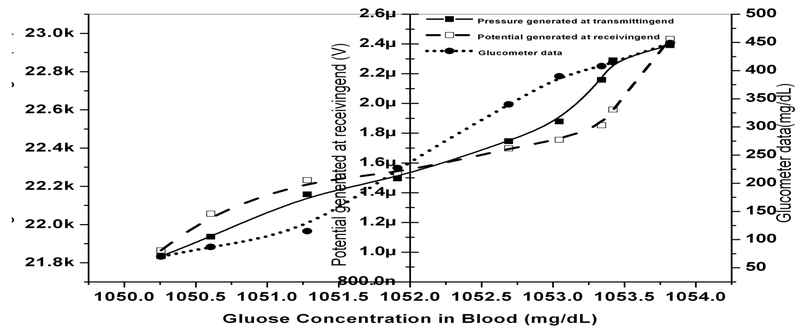


Figure 4. Comparison results of pressure , and glucometer data.

- **In simulation environment, the glucose density in blood was varied from 1050-1054 Kg/m^3.**
- **The pressure and potential at a point in the blood medium increases with density in this range as it is seen using commercial glucometer reading.**
- **The comparison of both the measured data and the simulated data are plotted in Figure 4.**

Conclusions:

BT can be used as a material for ultrasonic trance-receiver MEMS device. Hence it is environmental friendly and bio safe piezoelectric material to be used as ultrasonic glucose sensor.

References:

1. J. Diamond:"Diabetes in India", Nature, Vol 269, Jan 2011,pp 478-479 .

2.P. Pattnaik, S. K. Pradhan, S. K. Kamilla, D. P. Das, "Studies of Lead Free Piezo-Electric Materials Based Ultrasonic MEMS Model for Bio Sensor," Proceeding of COMSOL Conference 2012, Bangalore , dated 3rd -4th Nov 2012.

3. Piezoacoustic Transduser, Solved with COMSOL Multiphysics 4.3.