Design and Analysis of Multilayered MEMS Microphone using COMSOL Muliphysics®

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Introduction: The initial step in the recording process is the transduction of sound pressure waves into electromagnetic signals. The main type of transducer in audio recording is the microphone. The microphone changes air pressure variations into electric signals which vary proportionally. There are several types of microphone: dynamic (moving coil and ribbon), capacitor (also known as condenser) are the main types. Each type has particular strengths and weaknesses. Choosing a microphone is much like selecting an instrument: there is no single ideal microphone for a given situation, but some types sound better than others for particular applications. Choosing appropriate microphones makes the job of recording easier, since processing like equalization can be obviated if a certain microphone produces the desired sound directly. While it helps to understand the basic principles of microphone design, there is no substitute for experience and experimentation**.**

Dynamic Microphone
Capacitor/Condenser Microphone

Structures Designed: Microphones are types of transducers, they convert acoustic energy i.e. sound signal. Basically, a microphone is made up of a diaphragm, which is a thin piece of material that vibrates when it is struck by sound wave. This causes other components in the microphone to vibrate leading to variations in some electrical quantities thereby causing electrical current to be generated. The current generated in the microphone is the electrical pulse. There are two major types of microphones based on the technical methods of converting sound into electricity namely the organic and condenser microphone. Condenser microphones generally have flatter frequency responses than dynamic, and therefore mean that a condenser microphone is more desirable if accurate sound is a prime consideration as required in this design.
Here the following shapes of diaphragms are designed namely,
1. Square shaped diaphragm
2. Rectangle shaped diaphragm

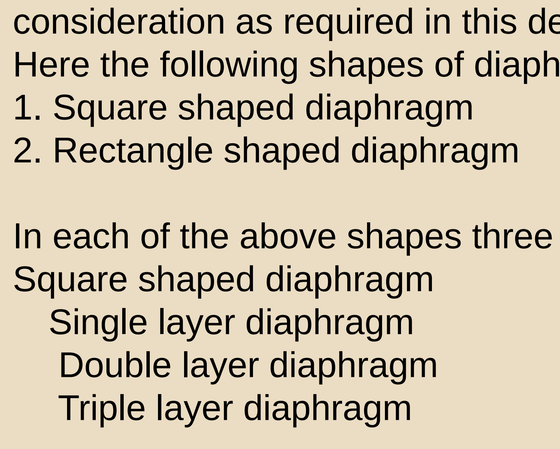
In each of the above shapes three designs are made which are as follows:
Square shaped diaphragm
- Single layer diaphragm
- Double layer diaphragm
- Triple layer diaphragm

Rectangle shaped diaphragm
- Single layer diaphragm
- Double layer diaphragm
- Triple layer diaphragm

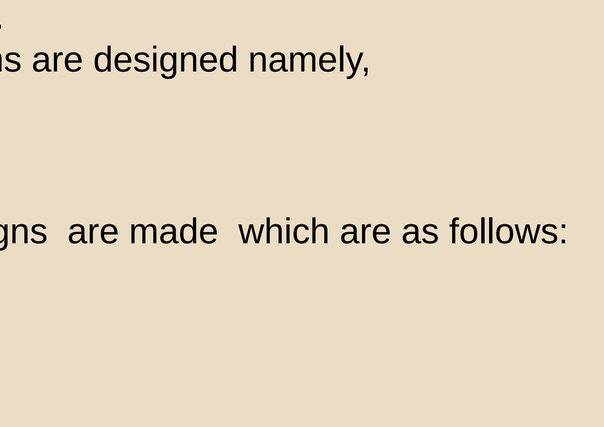
Results:

Deformation of Diaphragm with pressure

For Square membrane

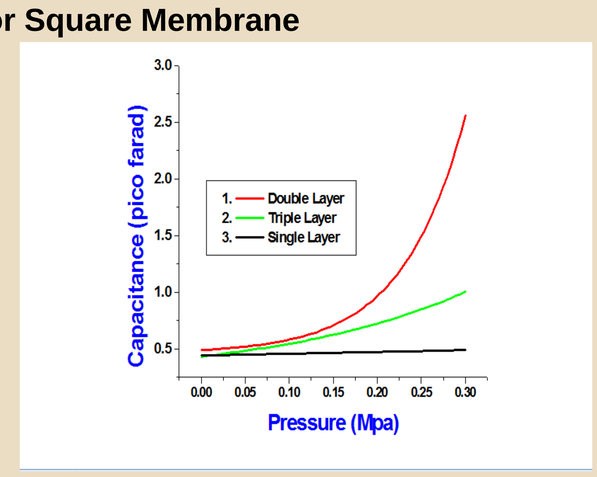


For Rectangle Membrane

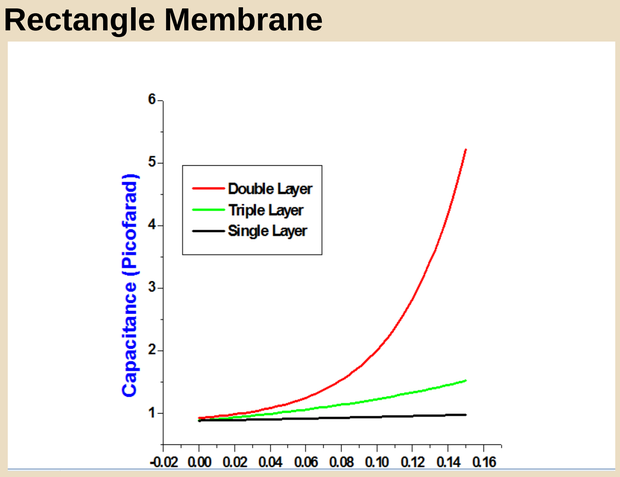


Capacitance with applied pressure

For Square Membrane



For Rectangle Membrane



Conclusions: The simulation of a pressure sensor with Si/PS composite membrane is reported. The results comparing characteristics of pressure sensors fabricated with membranes of (a) single crystalline silicon, (b) a Si/PS composite membrane with the same porosity and varying thickness of PS and (c) a Si/PS/Si composite membrane with the same depth and varying porosity of PS are presented. The results obtained by simulation have clearly demonstrated that Si/PS composite membranes lead to higher values of sensitivity depending upon the porosity and the depth.

This project generally deals with the design of voice recognizable microphone that uses Si/PS as a pressure sensor membrane. This design can be implemented by fabricating it using the bulk micromachining technique. In future, this model can be extended by using different materials other than Si/PS that offers high sensitivity and reliability.

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References:

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