Sensitivity Analysis of Different Models of Piezoresistive Micro Pressure Sensors

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Abstract

Piezoresistive pressure sensors are receiving maximum attention over other type of sensors because of easiness of fabrication, low cost, simple measurement techniques, wide range of pressure sensing, etc. There is always a challenge in design with respect to appropriate positioning of piezoresistance, shape and temperature compensation. Different models of piezoresistive pressure sensors are proposed to enhance its sensitivity in terms of output voltage and linearity. This paper aims in sensitivity analysis of various models which are proposed in research papers such as 'Bulk micromachined pressure sensor' by Lynn F. Fuller [1], 'Silicon pressure transducer' by Minhang Bao [2], 'Pressure sensor die' by Tai-Ran Hsu [3], 'Motorola Xducer' by Stephen Senturia [4].
The AC/DC Module and Acoustics Module of COMSOL Multiphysics® is used to make a comparative study of the models. All sensors used in this paper consist of a membrane, on which the pressure is applied and a surrounding fixed frame. The edge length of the square-membrane is 783 µm for each sensor. The edge length of the frame is 1000 µm and the thickness of both the membrane and the frame is 63 µm. The material of the whole diaphragm (membrane and frame) is single crystal, lightly doped n-silicon. The piezoresistance is of lightly doped p-silicon. A wheatstone bridge circuit is used for the measurement of change in resistance with a 5V supply. The sensitivity and range of output voltage of each model is measured over an applied pressure range of 0 to 100MPa and compared. The merits and demerits are discussed as a result of the paper.

Reference

1. L. F. Fuller, S. Sudirgo, "Bulk micromachined pressure sensor", University / Government / Industry Microelectronics Symposium - UGIM , pp. 317-320, 2003.
2. Minhang Bao, “Analysis and Design Principles of MEMS Devices”, 1st edition, Elsevier, pp.4-6, 2005.
3. Tai-Ran Hsu, “MEMS and Microsystems Design and Manufacture”, 1st edition, Tata McGraw Hill Education Private Limited, pp.254, 2002.
4. Stephen D. Santuria “Microsystem Design", Kluwer Academic Publishers, pp.481-485, 2002.

Figures used in the abstract

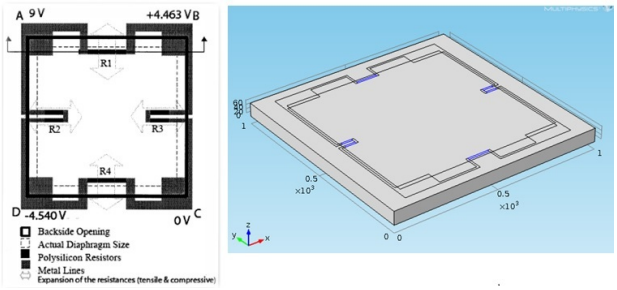

Figure 1: ‘Bulk micromachined pressure sensor’ by Lynn F. Fuller [1]

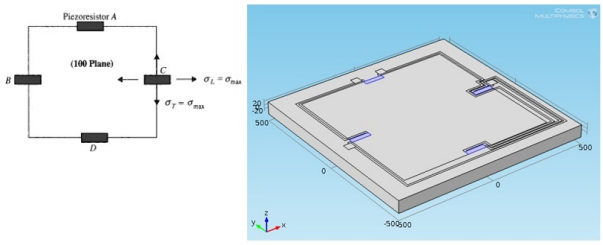

Figure 2: ‘Silicon pressure transducer’ by Minhang Bao [2]

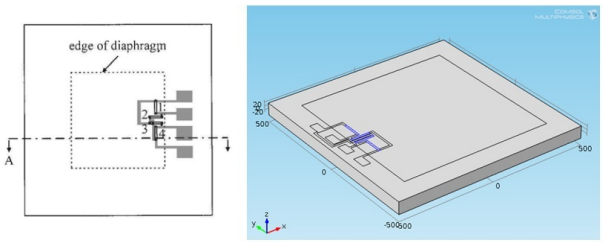

Figure 3: ‘Pressure sensor die’ by Tai-Ran Hsu [3]

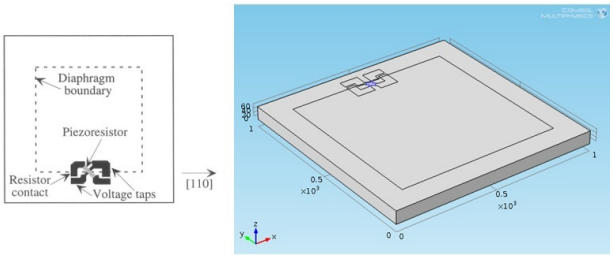

Figure 4: 'Motorola Xducer' by Stephen Senturia [4]