

MEMS Based Silicon Load Cell for Weighing Applications

D. Chauhan¹, B. D. Pant²

¹Electronic Science Department, Kurukshetra University, Kurukshetra, Haryana, India

²MEMS & Microsensors Group, CSIR-CEERI, Pilani, Rajasthan, India

Abstract

Load cells are force sensors, which are used in weighing equipment. Conventional load cells are made from steel or aluminium. When a load is applied, the metal part of the load cell deforms, which is measured by resistive strain gauges. To minimize hysteresis and creep, it is advantageous to make a load cell of silicon because in contrast to metals it does not suffer from hysteresis and creep. The objective of this work is to develop a MEMS based load cell. MEMS piezoresistive strain sensors are preferred because of high sensitivity, low noise, better scaling characteristics, low cost, wide range of force measurement etc. Furthermore, piezoresistive strain sensors need less complicated conditioning circuit. In this work, two different load cell designs were simulated. First design (Figure 1) is based on compressing a meander like polysilicon strain gauge for the measurement of high forces up to 10kN. Second design (Figure 2) is based on MEMS pressure sensor consisting of membrane (100 μ m thick), on which force (up to 500N) is applied keeping the surrounding frame fixed.

The Piezoresistivity interface in the Structural Mechanics Module of COMSOL Multiphysics® software is used for designing and simulation of our load cell models. For both designs, the frame/membrane is of single crystal, lightly doped n-type silicon. Piezoresistors are of lightly doped p-type polysilicon. Potential divider arrangement for first design, Wheatstone bridge circuit for second design is used for the measurement of change in resistance under applied load. The simulation results depicts the sensitivity and range of output voltage for both load cells measured over range of applied forces.

Reference

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Figures used in the abstract

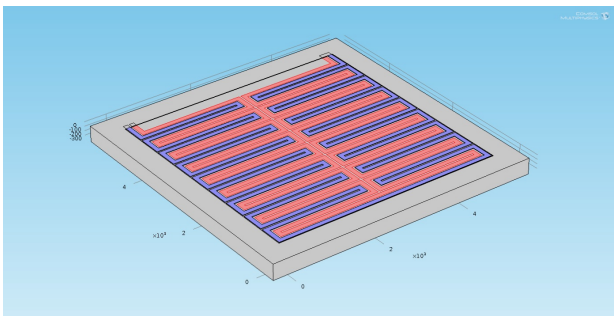


Figure 1: Meander shaped polysilicon piezoresistive silicon load cell.

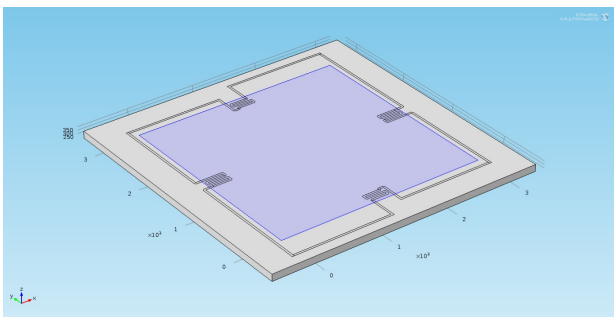


Figure 2: Pressure sensor based small silicon load cell.