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FEM Simulation and Performance Evaluation of MEMS Pressure Sensor Based onCapacitive Effect Using Molybdenum and Tungsten

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ABSTRACT

Microsystems have experienced a great deal ofdevelopment during the last years leading to more complex systems for sensing, analyzing, and actuating. It combines and integrates miniaturized sensors, actuators and electronics in a single device for various applications in different fields [1-2]. One of the major applications of thesedevices is the Micro Electromechanical System (MEMS) pressure sensors for tire pressure measurements [3-4]. In addition, these integrated devices have been used in airbagdeployment in automobiles since the nineties of the last century [3]. There are several types of pressure sensors, themost common MEMS pressure sensors categorizes are thepiezoresistive and capacitive effect one. Recently, (MEMS) capacitive pressure sensor gains more advantage over micromachined piezoresistive pressure sensor due to its high sensitivity, low power consumption, IC compatibility, better thermal stress etc. [5]. The working principle of capacitive effect MEMS sensor is based on twoparallel plates acting as electrodes of capacitors and separated by air gap, thus forming a square diaphragm. When the pressure over the sealed cavity changes, the pressure difference causes the membrane to deflect. The study of plate mechanical deflection in these devices calls on various notions of solid mechanics and electrical potential grouped together under the name of electro- mechanics in connection with the applied pressure. An electro-mechanical response of a capacitive pressure sensor would open a wide horizon of uses and should intensify the integration of MEMS devices. In general, theMEMS pressure sensor based on capacitive effect hasmany sorts of detecting and measurement problems relatedto external variables such as ambient or working temperature [4], therefore, different materials such as silicon, graphene, titanium, tungsten, molybdenum were investigated to obtain the material which has improved resistivity against temperature variation. In this paper, an analysis, FEM simulation of electrical and mechanicaleffects of MEMS based capacitive pressure sensor with high pressure sensitivity and small size, using the electro- mechanics interface by COMSOL Multiphysics software are described. This includes diaphragm deflection, sensitivity, capacitance vs. pressure analysis and thermal considerations. Subsequently, the detailed description of the model concept, its operating principle, the geometric parameters and the pressure and thermal effects simulationare presented. Therefore, a discussion of the simulation results with a focus on the sensitivity of the sensor and its performance against temperature are compared to other work [5-6]. In addition, the packaging stress effect on diaphragm deflection, sensitivity and capacitance vs. pressure analysis and thermal studies underthe working

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range of 290 to 300 K° are investigated. The pressure and temperature variation affect the magnitude ofthe diaphragm deflection and consequently on the capacitance and sensitivity (the gradient of the curve Capacitance Vs Pressure) of the MEMS sensor. The simulation results showed that the molybdenum capacitiveMEMS pressure sensor has high resistivity againsttemperature variation with a change in capacitance of 0.01% in the prementioned operating temperature range, while other materials depicted in other works showed a variation of 5.535% and 1.564% for silicon and graphene at the same operating temperature range [5,6].

Keywords: MEMS Sensors, Capacitive Pressure Sensors, COMSOLMULTIPHYSICS, FEM simulation.

References

1. D. K. Miu, Y. C. Tai: Silicon micro-machined scaled technology, IEEE Trans. Industr. Electron. 42 (1995) 234–239.
2. T. R. Hsu: MEMS and Microsystems (McGraw-Hill, Boston 2002)
3. H. Kapels, R. Aigner, C. Kolle: Monolithic surface micro-machined sensor system for high pressure applications, Technical Digest, Int. Conf. Solid-State Sens. Actuators, Munich 2001 (Transducers Conference, Chicago 2001) 56–59.
4. W. H. Ko, Q. Wang: Touch mode capacitive pressure sensors, Sens. Actuators 75 (1999) 242–251.
5. N. Anadkat, M J S Rangachar, Simulation based Analysis of Capacitive Pressure Sensor with COMSOL Multiphysics, International Journal of Engineering Research & Technology (IJERT).Vol. 4 Issue 04, April-2015.
6. Rashed Al Amin and al., Simulation Analysis of Capacitive Pressure Sensor for MEMS Using Graphene, International Conference on Materials, Electronics & Information Engineering, ICMEIE-2015.

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