Fabrication of the piezoresistive pressure sensor using implantation steps

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Abstract

The paper presents solutions of conventional piezoresistive pressure sensors. Deflection of diaphragm by external stress causes some problems, because the electrode is deposited on the diaphragm formed piezoresistors. To solve these problems, piezoresistors is formed by two implantation steps. To fabricate diaphragm, the backside silicon etching step is done by immersing the wafer into TMAH solution. 30 ㎛ thick diaphragm is obtained. Sensitivity of the piezoresistive pressure sensor fabricated is 48.6 ㎷/V-psi.

1. Introduction

There are a number of ways to go about designing and building an integrated sensor.

Conventional piezoresistive pressure sensors are mostly made by forming diffused or implanted piezoresisitors in thin silicon diaphragm. The conventional process was conducted by the one step to form piezoresistors. Deflection of diaphragm by external stress causes some problems, because the electrode is deposited on the diaphragm formed piezoresistors : peeling off the metal layer from the substrate, degradation of sensitivity, difficulty for controlling the offset voltage and degradation of thermal properties. Therefore, this thesis proposes a method of forming piezoresistors using two implantation steps. As a result, the electrode is placed on the outside of the diaphragm formed piezoresistors.

2. Fabrication

A brief process flow for the piezoresistive pressure sensor is illustrated in Fig.1 and described as follows. On bare silicon wafer, a 7000 Å thick oxide layer is deposited by wet oxidation, followed by the oxide layer is etched by B.O.E. solution. BF_2 ions are implanted into the silicon. After patterning the oxide layer, implantation process is conducted. After implantation, wafer was diffused in a furnace at 1000 ℃ for 35 minutes in a nitrogen atmosphere to form piezoresistors. The backside silicon etching step is done by immersing the wafer into TMAH(TetraMethylAmmonium Hydroxide) solution. Finally, Al layer is deposited and patterned to make electrodes.

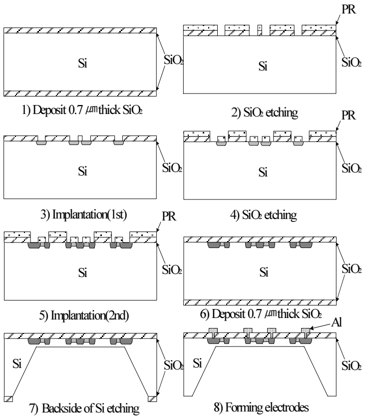

Fig. 1 Processing steps to fabricate the piezoresistive pressure sensor

The implanted dose of BF_2 is different in each step. In the first step, BF_2 ions are implanted on the silicon surface for forming piezoresistors. Conditions of implantation are that energy is 75 keV, the implanted dose of BF_2 is 2.0×10^{14} ions/㎠, wafer is rotated with 1000 rpm during the implantation process. In the second implantation, conditions of implantation are that, energy is 75 keV, the implanted dose of BF_2 is 7.0×10^{15} ions/㎠.

4. Results and discussion

Physical structures were measured during the course of processing. Diaphragm thickness is 30 ㎛ and Aluminum thickness is 0.3 ㎛. The depth of piezoresistors formed is 2 ㎛ and 3 ㎛ respectively. The response of the system was measured by amplifying the output of the Wheatstone bridge with a simple amplifier circuit. Input was 2.32 V AC at about 100 Hz, shown Fig. 2.

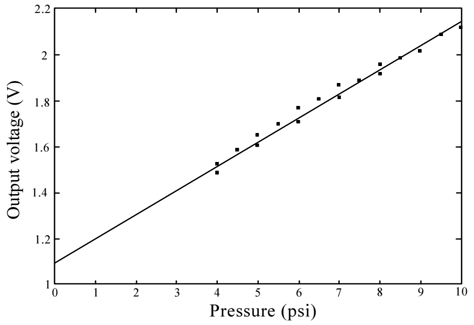

Fig. 2 The response of the system

5. Conclusions

The size of the piezoresistive pressure sensor fabricated is 2700×2700×500 ㎛. To solve the problems of conventional piezoresistive pressure sensors, it proposes that two implantation steps are conducted to form piezoresistors. Sensitivity of the piezoresistive pressure sensor fabricated is 48.6 ㎷/V-psi. In the future, the piezoresistive pressure sensor fabricated is sealed by bonding technologies. We can be applied to high pressure ranges such as tire pressure sensors.

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