Micromachined capacitive pressure sensor with signal conditioning electronics

Micromachined capacitive pressure sensors for harsh environment together with interfacing electronic circuits have been studied in this project. Micro-electromechanical systems (MEMS) have been proposed as substitutes for macro scale sensor's systems in many different fields and are the only possible solution in many cases where, for example, the dimensions of the sensing element is the limiting factor. Furthermore, MEMS can significantly reduce costs and power consumption being the best candidate for consumer electronics such as mobile phones and cameras, or for the automotive industry where a great deal of sensors are used. Pressure sensors are among the most successful MEMS and are used in a huge variety of applications. In this project an absolute capacitive pressure sensor has been developed with the aim to integrate it in pump control systems to improve the efficiency of the pump.

The developed MEMS consist of hermetically sealed vacuum cavities surrounded by two heavily doped silicon layers which constitute the plates of a capacitor. The top plate is also the sensing element being a thin diaphragm that deflects when pressure is applied, thus increasing the capacitance (i.e. the output signal) of the device. Fusion bonding of two wafers has been used in order to obtain the cavities, this is also the only non-standard cleanroom process involved in the fabrication of the transducers. The device developed can measure absolute pressures from 0 to 10 bar with sensitivity up to 80 pF/bar.

As a part of the project a suitable interfacing circuit has been developed. Different solutions have been studied in order to optimize size, costs, sensitivity and stability. A comparative analysis between them has been carried out and suggestion for the final product has been proposed.

Both the electronic conditioning circuits and the MEMS have been fully described with mathematical models and simulated with electrical networks software for the circuit part and finite element for the sensor part. A good matching between analytical models and simulations results has been achieved. Furthermore, the experimental results are in good agreement with the models proposed.

Finally a demonstrator has been fabricated under the constraints of a previously designed case in order to contain costs; modification or re-design of the packaging is in fact one of the major costs for the MEMS industry. This demonstrator has been characterized and presented at Grundfos Direct Sensors A/S and constitute the preliminary work for a new product which is intended target the low power or wireless pressure sensor for harsh environment market.

**General information**
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Fragiacomo, G., Hansen, O., Thomsen, E. V., Kjærgaard, C., Christensen, C.
Number of pages: 128
Publication date: 2012

**Publication information**
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Research output: Research › Ph.D. thesis – Annual report year: 2012