THERMAL EFFECTS IN DESIGN OF INTEGRATED CMOS MEMS HIGH RESOLUTION PRESSURE SENSOR

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Abstract—Thermal effects in integrated piezoresistive MEMS pressure sensor may be a problem of concern in design for applications requiring high precision measurements and in continuously monitoring array of sensor network. It not only results in the shift of the offset voltage of the pressure sensor but also affects the performance of the adjacent CMOS circuit leading to erroneous values. To address this problem, the thermal effects of the integrated sensor chip along with its packaging arising out of the self heating of piezoresistors has been analyzed through a simple heat balance model which has been validated by FEM analysis and laboratory experiment. It is observed that for a typical packaged pressure sensor of 5.6mm by 5.6mm and heat transfer coefficient of $100 Wm^{-2}K^{-1}$, thermal effect may lead to a temperature rise of around 5^0C whereas for a high precision application of pressure sensor even 1-2^0C of temperature rise may lead to significant error. A methodology of co-design and a new MOS library called PTMOS for direct integration of these thermal effects of MEMS piezoresistors in the CMOS circuit has also been presented to reduce considerably the design cycle time of the integrated sensor. This integrated analysis thus helps in proper selection of the dimensions and packaging of the integrated sensor chip taking into account the thermal effects for the optimization of its space constraint and its performance with reduced design cycle time.

***Index Terms*—Thermal effects, MEMS piezoresistive pressure sensor, dynamically linked library, CMOS MEMS integration**