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Monolithical Integration of Channel Structures on Thermal Flow Sensors

ABSTRACT - Masterthesis

The aim of this work is to find a compatible technology, to integrate microchannels monolithically on thermal flow sensors which makes the sensors suitable for sensing very low flow rates. The focus is on process development and testing its feasibility. The thermal flow sensors have already been made and tested in IMSAS (Institute for Microsensors, -actuators, and -systems). Since the feasibility is not known, the process flow has been designed such as to utilise the masks for thermal flow sensors as much as possible, to reduce cost. Two new slide masks have also been prepared.

The fundamentals of fluid flow and heat transfer have been reviewed in order to understand the working of the thermal flow sensor. A theoretical model has been revised in order to compare the experimental results. The fluid taken here is water.

For the fabrication of the thermal flow sensor, the passivation of the sensor from the channel has been done by a low temperature process of PECVD instead of the high quality LPCVD process, to avoid diffusion of the two thermopile metals. The rectangular channels have been realised by surface micromachining using Copper as sacrificial layer. The channel's inner surface is made of three successive layers of Silicon oxide, Silicon nitride and Silicon oxide respectively. Silicon oxide provides a chemically inert surrounding to the fluid. Silicon Nitride acts as a moisture barrier since Silicon oxide is porous. The third layer, consisting of Silicon oxide is used as an adhesion layer for SU-8 which is a negative polymer photoresist, used as an outer cover for the microchannels. The process development deals with the problems encountered with SU-8. Tests have been conducted to improve the adhesion and reduce the stress in SU-8 layers of two different formulations (commercial product of Microchem) and their results have been implemented in the process flow.

The last part consists of the characterisation of the fabricated sensor-channel system, for which, a polymeric (Polycarbonate) flow cell has been designed. The sensor characteristic curve for water has been measured and the frictional resistance of the micro-channel has been calculated. The flow rate and pressure drop measurements have also been performed. The results as well as the associated problems have been analysed and discussed.