Wafer Level Fabrication of an Integrated Microdispenser with Electrical Impedance Detection for Single-cell Printing

A. Yusof 1, K. Kalkandjiev 1, J. Schöndube 1, P. Koltay 1, R. Zengerle 1,2
1Laboratory for MEMS Applications, Department of Microsystems Engineering (IMTEK), University of Freiburg, Germany
2Centre for Biological Signaling Studies (BIOS), Freiburg, Germany

Introduction
In previous work [1], we presented a microfluidic based dispenser for printing of single particles or cells. The single particle detection has been implemented using a computer vision system, which is robust, but unable to obtain accurate information about the particles/cells’ velocity. Therefore, as an improvement to the sensor systems, the electrical impedance detection technique is employed [2]. Two sets of electrode pairs (parallel facing) are embedded in the microchannel that serve to detect individual particles flowing through the electrodes and to measure their transit times before dispensing through the nozzle.

Electrical Impedance Detection Principle
Two types of electrodes configurations are normally implemented for the flow through impedance measurements of single cells:-
- A co-planar electrodes
  - (fig. 1a) – The electric field distribution in the detection area is inhomogeneous. Thus, the detection signals is dependent on the particle position.
- A parallel facing electrodes (fig. 1b) – The electric field distribution is virtually homogenous between the electrodes space. The detection sensitivity is less dependent to the particle position.
- Transit time, \( \Delta t = t_B - t_A \)

Fabrications (Parallel Facing Electrodes)
- Thermal oxide: growth of 500 nm SiO2 as passivation layer.
- Patterning of 300 nm Platinum electrodes
- Pyrex wafer:
  - Patterning of 300 nm Platinum electrodes
  - Opening of hydraulic access holes via deep wet etching.
- Lamination of TMMF and development of microchannels

Device packaging:
- Bonding at 75 °C & dicing.

Conclusions
We have successfully demonstrated a wafer level fabrication of a microfluidic dispenser featuring an integrated impedance sensor. The measured signals for single polystyrene beads demonstrate the functionality of the sensor system.


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