A MICROFABRICATED THERMO- ELECTRICAL FIELD FLOW FRACTIONATION SYSTEM

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Abstract:
This work introduces a microfabricated Thermo-Electrical Field Flow Fractionation System (μTEFFF) with potential use as an integrated sample preparation system in a μ–TAS. The paper addresses design, modeling, and fabrication of the device.

Keywords: Sample Preparation, Field Flow Fractionation, Separation

1. Introduction

Reports [1], [2] on various miniaturized field flow fractionation (FFF) subtypes have shown their potential as a sample preparation system in the μ-TAS. This paper introduces another microfabricated FFF subtype, a combination of thermal and electrical FFF, which was first described on macroscale in 1991 [3]. This device finds application in preliminary separations prior to sensing or analysis step in stand-alone or μ-TAS based biological assays and protein adsorption studies.

2. Theory

In μ-TEFFF, combined thermal and electrical fields in the direction perpendicular to the flow of sample are used to induce the separation. This transverse field forces particles towards the accumulation wall (Figure 1) and the parabolic velocity profile in the channel causes particles to elute at different times depending upon their protrusion into the channel. Combining the two fields in a μ-TEFFF device enhances selectivity as separation can be based on two criteria, electrophoretic mobility [1] and thermal diffusion [2].

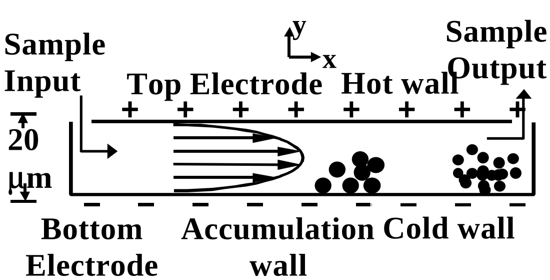

Figure 1 TEFFF system showing input and output ports, application of electric field, thermal field, parabolic flow profile, and relative channel dimensions.

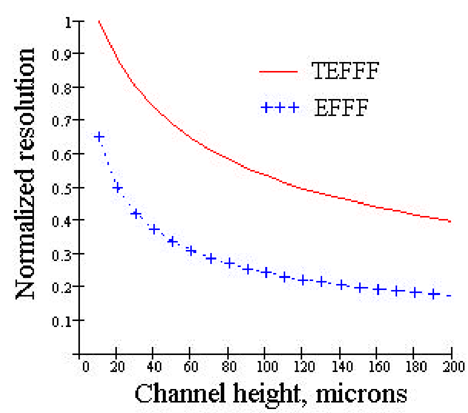

Figure 2 Comparison of normalized resolution for TEFFF and EFFF systems.

3. Modeling

Scaling models for TEFFF were prepared to study the effect of miniaturization on performance of the device and to compare this instrument with other FFF systems. The modeling results show improvement in resolution (and other performance measurement criteria) for TEFFF system with miniaturization and it also demonstrates better resolution when compared with electrical-FFF. (Figure 2) Heat transfer calculations were also carried out to decide the operating conditions of the device.

4. Fabrication and Results

The fabrication of the μ-TEFFF system (Figure 3) begins by etching the input and output ports of the channel using ICP, followed by sputter deposition of titanium heater. After spin coating a thin SU-8 insulation layer, titanium and gold electrodes (for electrical field) are deposited. SU-8 serves as the channel walls for the system. A glass slide with titanium and gold electrodes is bonded to the silicon wafer to enclose the channels. After fabrication of μ-TEFFF, integration with various microfluidic components and data collection system was done to complete the experimental setup.

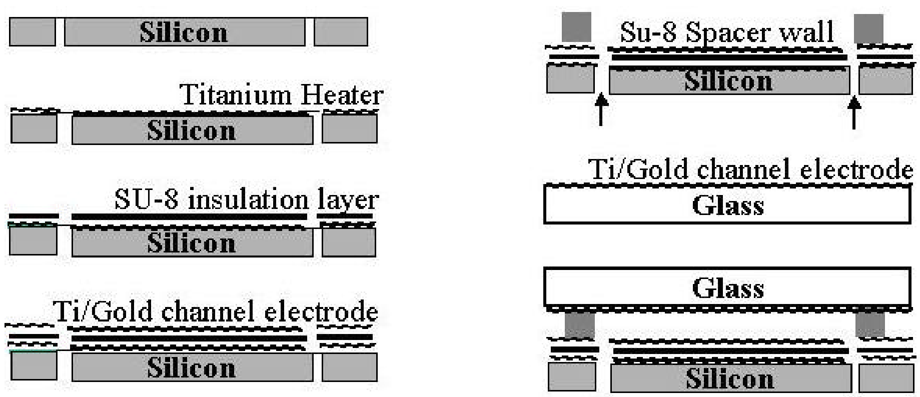

Figure 3 Fabrication flow chart for μ-TEFFF system

The initial characterization of the system has been done using standard polystyrene samples. Experiments were carried out to measure the improvement in the performance characteristics such as resolution and analysis time with encouraging results.

Acknowledgments

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References

1. B.K. Gale, K.D. Caldwell, and A.B. Frazier, "A Micromachined Electrical Field-Flow Fractionation System," *IEEE Tran. Biomedical Engineering*, 45, pp. 1459-1469, 1998.
2. T. L. Edwards, B. K. Gale, and A. B. Frazier, "A Micromachined Thermal Field-Flow Fractionation System," in *Proc. of Transducers '99*, 1999, pp. 742-745.
3. G. Liu and J.C. Giddings, "Separation of Particles in Nonaqueous Suspensions by Thermal-Electrical Field-Flow Fractionation," *Anal. Chem.*, 63, pp. 296-299, 1991.