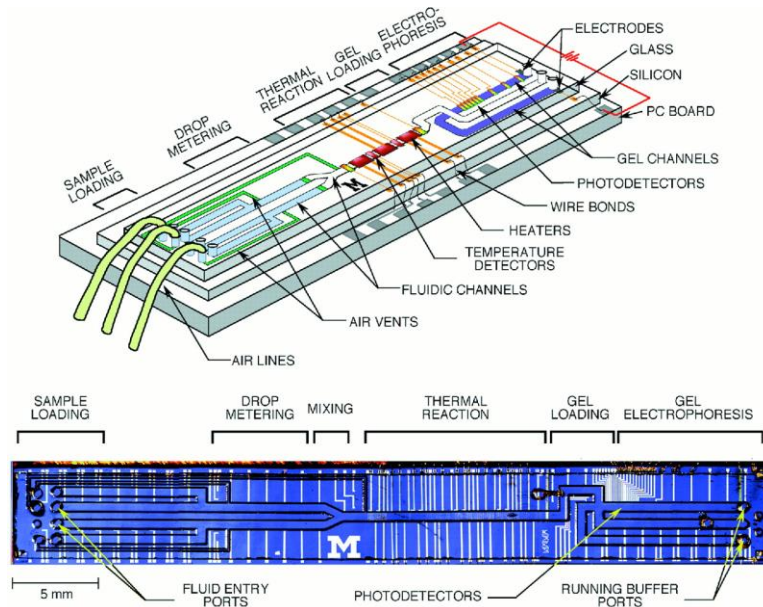


McMaster University, Department of Mechanical Engineering
ME 752: ADVANCED MEMS FABRICATION AND MICROFLUIDICS



Course Outline: Introduction, Microfabrication and micromachining, Surface and bulk micromachining, non-conventional machining, Microfluidics, Microchannels, Microvalves, MicroMixers, Micropumps, Droplet actuation, Integrated Systems.

Objective: To provide a detailed look into the various planar and non-planar fabrication methods employed for MEMS device design. To provide an in-depth look at the various methods and techniques employed for microfluidic actuation and control and its applications.

Instructor: Ravi Selvaganapathy, ETB 406, ext. 27435, selvaga@mcmaster.ca

Term: Winter

Text: None (*course notes and research articles provided by the instructor will be used*)

Supplementary Materials and References: Research articles provided by instructor
References – Books (several of these books are course reserves and can be accessed through Thode library)

Microfluidics:

1. G. Karniadakis, A. Beskok, N. Aluru *Microflows and Nanoflows: Fundamentals and Simulation*, Springer 2005
2. N. T. Nguyen, S. Wereley *Fundamentals and Applications of Microfluidics*, Artech House Publishers, 2002
3. O. Geschke, *Microsystem Engineering of Lab-on-a-chip Devices*, Wiley, 2008
4. G.A. Urban, *BioMEMS*, Springer, 2012 (e-book)
5. J. Berthier, *The physics of microdroplets*, Wiley, 2012

Design:

1. Stephen D. Senturia, *Microsystem Design*, Kluwer Academic Publishers, 2000
2. G.T.A. Kovacs, *Micromachined Transducers Sourcebook*, McGraw-Hill, 1998
3. Mohamed Gad-el-Hak, *The MEMS Handbook*, CRC Press, 2002

Microfabrication:

1. S. A. Campbell, *Science and Engineering of Microelectronic Fabrication*, Oxford University Press, 2005.
2. M. Madou, *Fundamentals of Microfabrication*, New York: CRC Press, 1997
3. M. Elwenspoek, H. Jansen, *Silicon Micromachining*, Kluwer Academic Publishers, 2001

Grading Scheme: Class Presentation: 40%, Assignments: 30%, Final Project 30%

Course Contents:

- 1) **Introduction** to MEMS and Microfabrication
- 2) **Conventional Microfabrication:** Silicon based: Surface Micromachining, Bulk Micromachining, Glass Micromachining
- 3) **Non-conventional Microfabrication:** Electro discharge machining, Laser Micromachining, LIGA, Microstamping and soft lithography, Stereo lithography, Focused Ion Beam machining
- 4) **Microfluidics:**
Microchannels: Flow in Microchannels, Fabrication methods.

Micro Mixing: Passive Mixers: Surface modification mixers, Spatial mixers, Concentration gradient generation. Active Mixers, Electrokinetic mixers, Ultrasonic mixers.

Microvalves: Passive Valves: Structural design. Active valves: Piezoelectric, Bimorph, Thermo pneumatic, Large scale integration, Thermal and pH responsive.

Micropumps: Micro-displacement pumps, Electric-field assisted pumps, Magneto-hydrodynamic pumps, Acoustic streaming (ultrasonic) pumps, Pumping based on interfacial tension, Rectified pumping, Knudsen pump.

Droplet motion: Electrowetting, Dielectrophoresis, Traveling wave methods, Droplet generation.
- 5) **Integrated Microsystems** for biological applications: Lab on chip systems, Polymerase chain reaction microchips, Immunoassay microchips, Massively parallel nucleic acid construction, DNA sequencing chips, Microfluidic interface for Mass spectroscopy, Microfluidic cell handling