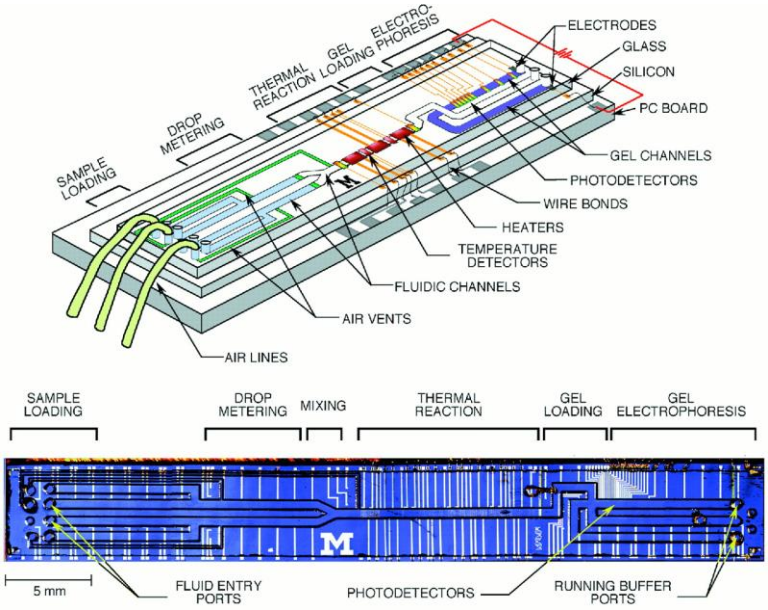
ME 752/BME 752/ ENGPHYS 752/ CHEM 750:
ADVANCED MEMS FABRICATION AND MICROFLUIDICS



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 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
4. Publishers, 2001

Grading Scheme:
Class Presentation/reports: 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**: Electrodischarge 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