

***Research Projects in  
Microelectromechanical Systems (MEMS) and  
Microfluidics***

***Luc G. Fréchette, Ph.D.***

***Associate Professor***

***Canada Research Chair in Microfluidics and Power MEMS***

**Department of Mechanical Engineering  
Université de Sherbrooke**

***Microengineering Laboratory for MEMS***

***<http://www.eureka.gme.usherb.ca/MEMSLab/>***

**Center for Research in Nanofabrication and Nanocharacterization (CRN2)**

**March 14, 2009**

## Research Themes

### **MICROS – Microengineering Laboratory for MEMS**

- **Development of MEMS: Microelectromechanical Systems**
  - Micro Fuel Cells
  - Microturbines
  - Micro generators (vibration energy harvesting)
  - Sensors and actuators for aerospace
  - Micro cooling
- **Fundamental studies of fluid flow and transport phenomena at small scales:**
  - Two-phase flows in microscale channels
  - Flow, heat, and mass transport in porous media
  - Moderate Reynolds number flows ( $10 < Re < 10,000$ ) in microscale geometries

Visit the lab's web site for more information:

<http://www.eureka.gme.usherb.ca/memslab/>

# Theme: Micro Fuel Cells

## Project: Micro/Nanofabrication of electrodes

### Introduction:

Micro fuel cells are non-polluting, compact power sources that promise a 10 fold improvement in autonomy for portable electronics. The amount of platinum catalyst required limits however their commercial viability.

### Project Objective:

Develop micro and nanostructured electrodes to optimize the fuel cell performance and minimize the platinum loading.

### Project Description:

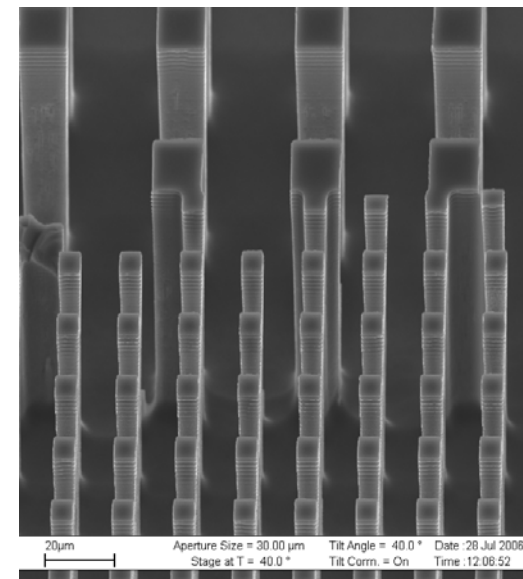
- Develop micro and nanofabrication processes to create Pt-activated electrodes for micro fuel cells:
  - Deep reactive ion etching for 3D structures
  - Self-assembly and growth of nanostructures
  - Nano-structuring of silicon surfaces
- Fabricate and test a hydrogen micro fuel cell based on these fabrication processes.

### Areas of interest:

Energy + microengineering + nanotechnologies

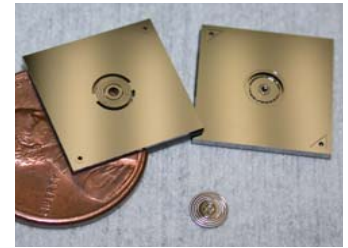
Level: master's or doctorate

Funding available (NSERC): \$16500 - \$19000



# Theme: Microturbines

## Project: Development of micro journal bearings



### Introduction:

We are developing MEMS-based microturbines that will allow the miniaturization of power-plants on a chip. These will be used to generate electricity for portable electronics or even to improve the efficiency of cars by recovering waste heat from the exhaust.

### Project Objective:

Develop the next generation of bearings for MEMS-based microturbines to allow high speed (>1 million RPM), stable operation.

### Project Description:

- Model the dynamics of micro rotors and micro journal bearings
- Conceive novel micro journal bearings configuration based on foil bearing technologies.
- Microfabricate and experimentally characterize the natural frequencies and damping in the new bearings (PhD only)

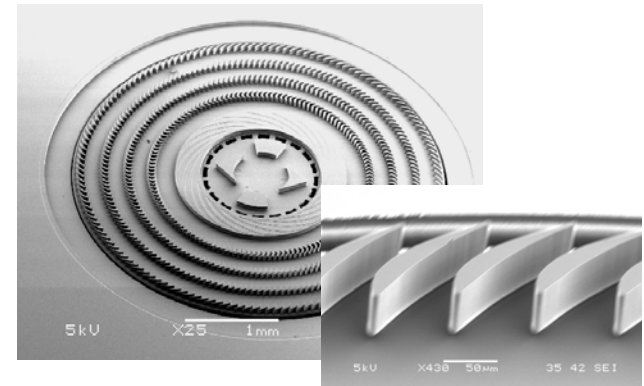
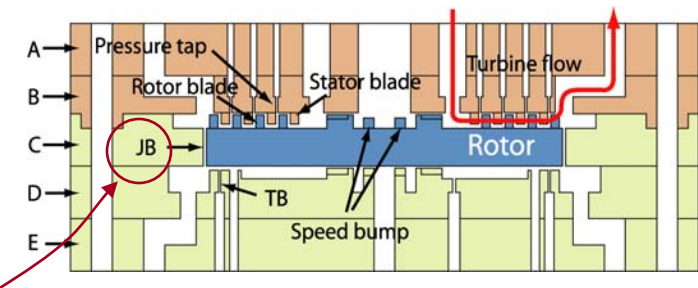
### Areas of interest:

- Dynamic fluid and structural modeling + MEMS

### Level: master's or doctorate

### Funding offered (NSERC): \$16500 - \$19000

*In Collaboration with GM Canada and McGill Univ.*



# Theme: Micro Generator (Vibration energy harvesting)

## Project: Microfabrication of Piezoelectric Resonators

### Introduction:

Our world is becoming increasingly connected, in which wireless sensors will be integrated in our surroundings to improve safety and monitor our environment and our health. The lifetime of distributed sensors is however limited by their energy source. We are developing micro energy harvesting approaches that convert ambient vibrations into electricity to remove this limitation and enable an *intelligent* world.

### Project Objective:

Develop to microfabrication processes to create high power density piezoelectric vibration energy harvestors based on MEMS technologies. This project is in collaboration with a team of researchers focusing on the design and material challenges.

### Project Description:

- Develop a microfabrication process to create crystalline piezoelectric ceramics (PZT) microstructures, integrated with electronics
  - Bonding of PZT and Si
  - Vacuum packaging
  - Laser micromachining or etching of PZT
- Device fabrication in clean-room
- Experimental characterization of the devices

### Areas of Interest:

- Microfabrication + MEMS + Experimental

**Level: master's or doctorate**

**Funding available (NSERC): \$16500 - 19000**

*In Collaboration with GM Canada and McGill Univ.*

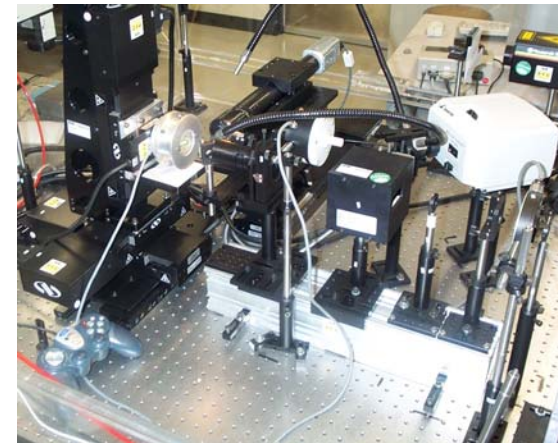


*For information: Prof. Luc Fréchette*  
Room C1-4068, (819) 821-8000 ext. 62799,  
[Luc.Frechette@USherbrooke.ca](mailto:Luc.Frechette@USherbrooke.ca)

### Cleanroom Infrastructures



### Excimer Laser Micromachining



*P. Masson, U. Sherb.*



<http://www.eureka.gme.usherb.ca/MEMSLab/>