Current State of MEMS Technology in Canada

Canadian Microelectronics Corporation

A Cost-Effective Nationwide Laboratory for Canada’s Universities to enable world-class Research and Training in Microsystems and Microelectronics

Established in 1984 as a collaboration between Canadian industry, universities and the Federal Government
Canadian Achievements

Some examples from universities:

- Jed Harrison, University of Alberta
  - Microfluidics: the first to use fluorescence detection with applications to single cell analysis, clinical diagnostics, and genetic analysis

- Michael Brett, University of Alberta
  - U of A MicroFab facility

- Ted Hubbard, DalTech
  - SEGS on-line wet etch simulator

- Ion Stiharu, Concordia University
  - Micro-pressure sensors and tactile imager for the space dexterous hand

Micromechanical D/A converter used in micromachine doptical multiplexer (Professor Ash Parameswaran, Simon Fraser University)
More Canadian Achievements

Some examples from industry:

- **Micralyne Inc. (formerly AMC)**
  - non-captive MEMS fab since late 80’s
  - Microfluidics Tool Kit “uTK”

- **i-STAT Corp.**
  - manufacture of fluid analysis systems

- **Goal Semiconductor**
  - on-chip temperature compensation, microbolometers, and diffractive optics

- **Cronos (a JDS Uniphase company)**
  - only MEMS supplier of bulk, surface, and high-aspect ratio micromachining

- **Xros (acquired by Nortel Networks)**
  - a leader in fully photonic switching networks
MEMS Research Infrastructure

- **INO (National Optics Institute)**
  - manufacturing processes for micro-optical components

- **Photonics Research Ontario (PRO)**
  - in-house laser micromachining for material research investigations, product prototyping and small volume production services.

- **Institute for Microstructural Sciences (IMS) at the National Research Council of Canada (NRC)**
  - in-house fabrication using surface micromachining techniques

- **Canadian Microelectronics Corporation (CMC)**
  - multi-project runs for academic researchers
CMC is a Not-for-Profit Corporation

CMC’s Mission:

• CMC will **stimulate and support the pursuit of excellence in research**, scholarship and training in microelectronics and Microsystems at Canadian research and education institutions

• CMC will **enable the development of people** who have the enterprise, knowledge and skills in microelectronics and Microsystems needed to contribute to the Canadian community

• CMC will actively **support the transfer of research and expertise into practical applications**, in partnership with research, educational and commercial organizations
How did CMC get into this?

- 1980s: University Pioneering work
- CMC supports university research:
  - 1994: access Mitel 1.5-micron CMOS
  - 1996: post-processing recipe “Can-MEMS”
  - 1999: Micromachining Workshop
  - 2001: Micromachining Workshop
CMC Manufacturing Roadmap

- Leading-edge MOS: 0.18-micron today, 0.1-micron by 2005
- "RF": 45 GHz SiGe option in 2001, 100 GHz option by 2005
- MEMS: MUMPs & CMOS today, next-generation research options for surface and bulk by 2005
- Optoelectronics: spec with NRC, expand in step with research and development interests by 2005
- Packaging (cross-cuts the above): conventional today leading into finer features, BGA/COB/MCM, with increasing customization
"BEAMS"

- Web-based“Info-center”
- “BEAMS Chamber”...database of MEMS researchers and capabilities
- Links to CMC-supported technology...
CMC support for MEMS

1999-Present: BEAMS Program

- Bulk processing using 1.5 micron CMOS with user-based postprocessing
- Surface micromachining through Cronos’ Multi-User MEMS Processes (MUMPs) program
- Memscap MEMSPRO CAD package and technology files available to qualified members (based on Tanner LEDIT)
- Cadence-based design kit (CAD tools, technology files)
Research Activity Flow

Design -> Merge -> Fabricate

-- Operated by CMC --

Package -> Test

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SOCIÉTÉ CANADIENNE DE MICRO-ÉLECTRONIQUE

Workshop on MEMS for Aerospace Applications, Ottawa, 12 April 2001
Multiproject Fabrication Run... Type 2

4 designs (or design libraries) from 3 universities use Cronos MUMPS for MEMS research
Universal test box for MEMS  
(Professor Ion Stiharu, Concordia U)

Looking Ahead

Initiatives at Canadian universities:

- **McGill University** (Peter Gruetter) - $6 million CFI grant for MEMS/ micromachining facility

- **École Polytechnique** (Michel Meunier) - MEMS applications in aerospace, biomedicine and electronics. A $10 million MINI grant will help support MEMS work.
Looking Ahead

Canadian industry:

- Continued technology development and marketing.
  - **Example:** i-STAT produces tens of millions of biosensor MEMS devices annually.

- Increased collaborative research with universities facilitated by infrastructure organizations such as CMC, NSERC, and PRO and new funding initiatives.
  - **Example:** NSERC/COM-DEV Industrial Chair with focus on RF-MEMS at the University of Waterloo
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<th>UNIVERSITIES</th>
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<td>McGill University</td>
<td>Optics, Technologies, Sensors-Actuators-MEMS devices</td>
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<td>University of Waterloo</td>
<td>Optics, Telecom, Micro Fluidics, CAD-Modeling-Simulation</td>
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<td>University of Manitoba,</td>
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<td>Concordia University</td>
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<td>University of Calgary</td>
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## Companies and Institutes, MEMS

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<th>INSTITUTE &amp; INDUSTRY</th>
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<td>Photonics Research Ontario</td>
<td>Optics, Technologies (Laser Micromachining)</td>
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<td>Micralyne Inc</td>
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<td>Institut National d'optique (INO)</td>
<td>Optics, Technologies</td>
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<td>Institute for Microstructural Sciences (NRC)</td>
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<td>Medtronic of Canada Limited</td>
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<td>Mitel Semiconductor,</td>
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<td>COM DEV International, Corporate</td>
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<td>i-STAT Corp</td>
<td>Technologies, Micro Fluidics</td>
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<td>JDS Uniphase Corporation</td>
<td>Optics</td>
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<td>Infolytica Corporation</td>
<td>CAD-Modeling-Simulation</td>
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<td>Integrated Engineering Software</td>
<td>Simulation Software (Micro Fluidics, Sensors-Actuators-MEMS devices)</td>
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SOCIÉTÉ CANADIENNE DE MICRO-ÉLECTRONIQUE

Workshop on MEMS for Aerospace Applications, Ottawa, 12 April 2001
Closing Remarks

- **Canadian universities**
  - significant achievements, wide range of ongoing research
  - new facilities and infrastructure via new funding initiatives

- **Research infrastructure**
  - organizations provide expertise and access to fabrication

- **Canadian industry**
  - need access to research expertise and trained people
  - growing collaboration with university researchers
  - established base for development and production

Let’s add Canadian aerospace interests to the mix
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