

Nanotechnology in Canada

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This article provides you a snap shot of the recent developments in the field of nanotechnology in Canada, in particular as it relates to the opening of the **National Institute of Nanotechnology** (NINT), which was celebrated on June 22, 2006,

I. Nanotechnology in Canada

R&D activities in nanotechnology in Canada are spearheaded by the federal government, provincial governments, as well as universities and national institutes. Currently, establishment of a national nanotechnology strategy is being deliberated at the federal level. Out of a total of 20 institutes under the **National Research Council (NRC)**, 9 institutes are conducting R&D in nanotechnology. The major concentration of both research and industry can be found in Alberta, British Columbia, Ontario and Quebec. Most of these provinces have already established or will establish province-wide consortiums to promote economic development through nanotechnology. Current estimates of how many companies are engaged in nanotechnology-related activities range from 50 to 200, depending on the definitions used for “nanotechnology”.

The following are examples of some companies and research organizations located in the provinces that have the greatest nanotechnology-related activities.

Alberta

With the opening of the National Institute of Nanotechnology (NINT), a joint venture of the federal government, the University of Alberta, and Alberta provincial government, has upgraded the system in Alberta to promote and support nanotechnology research and economic development. **The University of Alberta** has spun off several companies in small technologies.

One example is **Micralyne Inc.**, one of the world’s largest independent MEMS foundries. As an industry leader, Micralyne offers unparalleled MEMS product development and commercial volume manufacturing, with core competencies in micromachining, thin film deposition, and test & assembly capabilities. Micralyne’s solutions are found in automotive sensors for control systems, optical switching technology in telecommunication networks, lab-on-a-chip devices for drug discovery, and commercial pre-press equipment for printing today’s most popular magazines. These types of devices are



Clean Room, Micralyne

used in many industries including communications, transportation, energy, and life sciences. Growth has been prevalent in all aspects of the company. Between FY2004 and FY2005, Micralyne increased its revenues by 53% and almost doubled its employee base from 82 to 150+ staff. Micralyne is also quickly establishing ties with the Japanese business community. In fact, 10% of its revenue is generated by business with Japanese clients. Mr. Chris Lumb, President & CEO of Micralyne, expresses his enthusiasm toward Japan. "Our expectation for the Japanese market is very high. With our Japanese partners continuing to recognize our technological capability and services, we plan on expanding further into the Japanese Market."

The Micromachining and Nanofabrication Facility (NanoFab) is key in assisting the local MEMS industry and nanotechnology researchers. Established in 1999 on the University of Alberta campus, over 90 research groups from six universities, 17 University of Alberta departments, three research institutes, and 17 companies have used the facilities at Nanofab. Micralyne used to be one of the most frequent users of this facility before it developed its own fabrication facilities.

British Columbia

The **University of British Columbia** research activities in materials science and especially in metallurgy are well known for their world-class levels. **The Advanced Materials and Process Engineering Laboratory (AMPEL)** : Director: Dr. George Sawatzky) is the center of this material science research, equipped with a nanofabrication center that offers Class-1000 clean rooms. At AMPEL, cross-disciplinary research has been conducted in fields from bio-materials, metal materials, to photonics.



AMPEL, The University of British Columbia

Traditionally, entrepreneurship in biotechnology/life science at the University of British Columbia has been very active. Recent trends show that a few start-ups are emerging in the area of nanotechnology.

One of the best examples would be **Zymeworks Inc.** Established in 2004, this company has been on a growth spurt, offering consultation services to companies that have needs in thermostability and substrate specificity of enzymes. Dr. Ali Tehrani, the president of the company expresses his enthusiasm to enter Japanese market.

In addition, a consortium to support nanotechnology related, NanoBC, was recently established.

Ontario

The province of Ontario has a large concentration of nanotechnology research. Under NRC, the following 5 research institutes conduct nanotechnology-related research: **The Institute for National Measurement Standards (INMS), The Steacie Institute of Molecular Science (SIMS), The Institute for Microstructure Science (IMS), The Institute for Aerospace Research (IAR), and the Institute for Chemical Process and Environmental Technology (ICPET).**

The CANMET Materials Technology Laboratory (CANMET-MTL), a division of Natural Resources Canada, is another key research institute located in Ottawa, Ontario. CANMET-MTL has nanotechnology projects in the areas of hydrogen storage and noxious gas sensors. Expansion of this activity into other aspects such as coatings, nano-composites and bulk structural nano-materials is being considered in a new Strategic Plan for the laboratory. This expansion would be augmented greatly by the proposed relocation of the laboratory from Ottawa, Ontario to **McMaster University's** McMaster Innovation Park in Hamilton, Ontario. The C\$6 million project would enable new equipment to be bought and specialized facilities to be built, and would assist collaboration with area universities like Toronto and Waterloo as well as with McMaster.

The **University of Toronto** is well known for its excellence in many science areas, and nanotechnology is not an exception. **The Energenius Centre for Advanced Nanotechnology** at the University of Toronto was the first nanotechnology specific research center in Canada, established in 1997. Its research areas are: nano-photonics, and nano-electronics. The director of the centre is Dr. Harry Ruda, who is also a technology adviser to the start-up company **Micromem Technologies Inc**, established in 2000.

The **University of Waterloo**, located in Waterloo, Ontario, offers the only **undergraduate program specialized in nanotechnology engineering** in Canada. The university is going to establish the Quantum Nano Center by 2010, investing C\$70 million. The center will house 500 undergraduate students as well as 125 master students.

Quebec

NanoQuebec is a consortium consisting of 6 universities and research centers in Quebec, established in 2001. This consortium aims at the establishment of a nanotechnology cluster by improving competitiveness of the Quebec industry in nanotechnology R&D. Thus far, NanoQuebec has invested C\$3 million in 18 research projects and C\$8 million in research infrastructures to provide technology support to local small and medium sized enterprises. In FY 2006, the consortium announced their second 5-year plan with one of the key messages to expand its activities to Japan, from their previously exclusive focus on the EU and the USA.

In Quebec, there are two NRC institutes conducting nanotechnology related research.

One is the **Industrial Materials Institute (IMI)**, and the other is the **Biotechnology Research Institute (BRI)**. Research and development in materials has traditionally been very active in Quebec, where there are large aerospace and auto-parts clusters as well as several production sites for aluminum (Canada is the 3rd largest producer of aluminum in the world.). NRC-IMI is one of the powerhouses of materials research in the province. Many companies from Canada and abroad have commissioned research at the institute, as the institute provides technology support to the local and international companies.

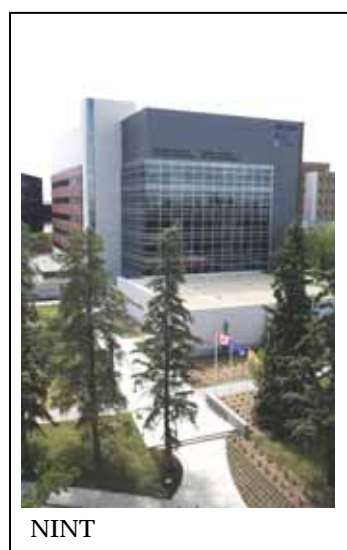
Raymor Inc. located in Montreal, Quebec, established AP&C Inc. in 1996 to commercialize a technology developed at McGill University. The company has been growing significantly in recent years in the sales of single walled carbon nanotubes and metal nano particles. **Tekna Plasma Systems Inc.** is another leading edge company that leads the local industry in small technology. Located in Sherbrooke, Quebec, this spin-off company from **Université de Sherbrooke** is also quickly growing by providing nano-particles to companies from all over the world including Japan. Of note, the Montreal region is the world's 4th largest bio-cluster, where there is a concentration of research in nano-bio related technologies.

II. NRC- National Institute for Nanotechnology: NINT

Canada's public research activities are conducted at both the federal and the provincial levels. The flagship research organization at the federal level is the National Research Council (NRC). NINT, (the 19th institute of NRC, established in Edmonton, Alberta in 2001) is a joint initiative of the federal government of Canada, the provincial government of Alberta, NRC and the University of Alberta. The concept of establishment of NINT is to provide, for the first time in Canada, a one-stop-shop of a vast range of research equipment to all researchers in nanotechnology across Canada.

“Quietest Space in Canada”

The city of Edmonton is located on the most stable bedrock of North America called the Canadian Shield. NINT takes full advantage of this environment by creating a research space that has the least possible interference from vibration and electromagnetic waves. During the construction of the NINT facilities many architectural features were incorporated to avoid possible interference in the laboratories. For example, upon entering the NINT building one has direct access to the administrative side of the building where there are conference spaces. One appears to have uninhibited access to the experimental areas but these two spaces



are in fact, two separate buildings, connected only by rubber seal to avoid the vibration caused by people walking in the administrative areas from affecting the experimental areas.

Overview of Research Activities

The **Canada Research Chair Program** was initiated in 2000 by the **Canada Foundation for Innovation (CFI)** with federal government of Canada, to establish 2000 research professorships - Canada Research Chairs - in universities across the country by 2008. The Canada Research Chairs Program invests C\$300 million a year to attract and retain excellent researchers in Canada. Thanks to this program and others dedicated to providing first class equipment, NINT is attracting some of brightest minds in the field to its facilities. Almost 70% of the 140 NINT researchers are cross-appointed at the University of Alberta. Currently, there are 140 research-related staff at NINT and the number is expected to grow to 200 by the year 2008.

NINT's main areas of focus are: life science, ICT, materials science and energy. In the field of life science, projects are underway to develop rapid, point-of-care diagnostics, and non-invasive treatment of medical conditions. In ICT applications of nanotechnology, NINT researchers conduct research activities to develop integrated biological and traditional information systems, molecular scale devices and systems, and ultra-thin films for electronics and photonics. In the areas of energy & advanced materials, ongoing projects include the development of nano-particles for energy storage and conversion, heterogeneous catalysis, nano porous media.

NINT leaders and researchers are very interested in collaborations with Japanese researchers and companies. "We consider Japan to be a priority for international partnership and are fortunate to have several researchers who have worked or studied in Japan," says Dr. Nils O. Petersen, the Director General of NINT. "Our interest in working with Japan is shared and supported by our local partner, the University of Alberta and our government partners."



Dr. Nils Petersen,
Director General, NINT

Research Activities at NINT

With the completion of the new building of NINT, all the researchers moved into their new spaces from their previous laboratory spaces on campus of the University of Alberta. This section introduces a few research activities out of five research groups and several subgroups at NINT.

The Theory and Modeling Group at NINT has been developing theory, modeling, and simulation of nanosystems on multiple length and time scales. Their approach integrates electronic properties, molecular simulations, molecular solvation and system functioning. They use integral equation theory to provide realistic physical and chemical descriptions of solutions, complex liquids, and other disordered systems, including nanoporous materials, solid solutions, and defects in crystals. The leader of the Theory and Modeling Group, Andriy Kovalenko, came to NINT in 2003 from the Okazaki National Research Institutes where he was a Visiting Associate Professor of the Institute for Molecular Sciences (IMS). He still maintains a close collaborative relationship with the research group of Prof. Fumio Hirata of IMS.

The Molecular Scale Device group, led by Dr. Bob Wolkow, explores device concepts, molecular structure, adsorption dynamics and the electrical transport properties of tailored organic-silicon interfaces. Their group's aim is the realization of molecular devices utilizing hybrid structures. An example application would be to mount organic molecules on silicon. To achieve that goal, they study the process that enables rapid auto-assembly of molecular structures.

NINT is also one of the key organizations in Canada which studies social, legal, health, and ethical aspects of nanotechnology R&D. Lori Sheremeta from the Health Law Institute at the University of Alberta is a NINT researcher focusing on the regulatory issues regarding nanotechnology. She has been an active researcher as well as advocator for the importance of ethics as well as regulations concerning health and environmental safety of nanotechnology, as well as other technologies such as life sciences.

Business Development and Common Use Facilities at NINT

Ensuring that the results of R&D have a positive impact on the local economy is an important part of NINT's mandate. In the past two decades, there have been almost 80 spin-off companies generated from University of Alberta. These companies are mostly biotechnology, health sciences or MEMS related. To accelerate this positive trend in the region, NINT is equipped with facilities that are available to industrial or academic researchers as well as local companies. On the 4th floor of NINT is the NINT Innovation Centre, which includes 15 rental units of office and lab space that can be configured for biological, wet lab, or dry lab research.

There are a variety of ways that clients can access facilities, people, or space at NINT. Clients can choose between contracting for equipment or lab time, collaborating with NINT researchers or sharing space with NINT by leasing lab and office space in the NINT Innovation Centre. "There is considerable interest from local and international collaborators." says Mr. Rick Brommeland, Director of Business Development and External Relations. "Industrial and

academic researchers are keen to take advantage of this state-of-the-art facilities at NINT."

Conclusion

This article introduced some of the examples of recent activities in nanotechnology in Canada. Canada's research system is diverse, reflecting different provincial priorities and competitiveness. Due to the cross-disciplinary nature of nanotechnology, however, there is a growing need to establish a national strategy for nanotechnology R&D in Canada.

As discussed in previous chapters, there are several regions in Canada where R&D in nanotechnology is concentrated and each region takes the initiative to bring further innovation and competitiveness to the industry in the region. In addition, there are a large number of researchers and companies that show strong interest in partnering with Japan. Such interest should be nurtured to establish more collaborations between Japan and Canada.

For further information, please contact:

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List of Links to the websites

(In order of appearance)

NRC National Institute for Nanotechnology

http://nint-innt.nrc-cnrc.gc.ca/home/index_e.html

National Research Council (NRC)

<http://www.nrc-cnrc.gc.ca/>

Micralyne Inc.

<http://www.micralyne.com>

Government of Alberta

<http://www.gov.ab.ca/home/index.cfm>

NanoMEMS Edmonton

<http://www.nanomems.org/>

University of Alberta

<http://www.ualberta.ca>

Micromachining and Nanofabrication Facility (Nanofab), University of Alberta

<http://www.nanofab.ualberta.ca/>

University of British Columbia

<http://www.ubc.ca/>

Advanced Materials and Process Engineering Laboratory (AMPEL), University of British Columbia

<http://www.ampel.ubc.ca/>

Zymeworks Inc.

<http://www.zymeworks.com/>

NanoQuebec

http://nanoquebec.ca/nanoquebec_w/site/index.jsp

NRC Industrial Materials Institute (IMI)

<http://www.imi.cnrc-nrc.gc.ca/english/Default.htm>

NRC Biotechnology Research Institute (BRI)

http://www.irb-bri.cnrc-nrc.gc.ca/home/index_e.html

Raymor Inc.

<http://www.raymor.com>

McGill University

<http://www.mcgill.ca>

TEKNA Plasma Systems Inc.

<http://www.tekna.com/>

Université de Sherbrooke

<http://www.usherbrooke.ca/>

NRC Institute for National Measurement Standards (INMS)

http://inms-ienm.nrc-cnrc.gc.ca/en/main_e.php

NRC Steacie Institute of Molecular Science (SIMS)

http://sims-issm.nrc-cnrc.gc.ca/main_e.html

NRC Institute for Microstructure Science (IMS)

http://ims-ism.nrc-cnrc.gc.ca/main_e.html

NRC Institute for Aerospace Research (IAR)

http://ims-ism.nrc-cnrc.gc.ca/main_e.html

NRC Institute for Chemical Process and Environmental Technology (ICPET)

<http://icpet-itpce.nrc-cnrc.gc.ca/research.html>

University of Toronto

<http://www.utoronto.ca/>

The Energenius Centre for Advanced Nanotechnology, University of Toronto

<http://www.utoronto.ca/~ecan/>

Micromem Technologies Inc

<http://www.micromeminc.com/>

McMaster University

<http://www.mcmaster.ca>

CANMET Materials Technology Laboratory, Natural Resource Canada

http://www.nrcan.gc.ca/smm/canmet-mtb/mtl/default_e.htm

University of Waterloo

<http://www.uwaterloo.ca>

Department of Nanotechnology Engineering, University of Waterloo

<http://www.nanotech.uwaterloo.ca/>

Canada Research Chair

<http://www.chairs.gc.ca/>

Canada Foundation for Innovation

<http://www.innovation.ca>

For any questions, please contact

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