Nanotech Innovation and Commercialization in Canada: The Role of Nano Ontario

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Canada’s Nanotech Hubs

Government & Agencies:
CSA Group
NRC
Global Affairs Canada, Industry Canada,
Health Canada
Environment Canada, NRCan
Tri-Councils, CFI, Genome Canada

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Harnessing Canada’s Investment in Nanotechnology Through Collaboration
An International Scientific Review Panel identified areas where Canada has the potential to make a significant impact:

- **Nano-materi**als: Functional & Soft Materials; Chemical Nanostructures & Self Assembly; Energy Storage and Conversion
- **Nano-biosystems**: Micro/Nano Fluidics; Biosensors; Lab-on-a-Chip; Targeted Nanoparticle Drug Delivery Systems
- **Nano-electronics**: Flexible/Organic Electronics; Nanophotonics; Optoelectronics and Quantum Computing
500+ Canadian companies involved in nano
Majority in advanced materials, healthcare, equipment and tools, structural materials, and electronic applications

1,000+ nano-enabled consumer products on Canadian market
2/3 imported (mostly from US/EU) (Industry/Health/Environment Canada databases)

70,000 jobs involve nano-enabled products/processes
4,657 jobs (<500 EE) + 68,741 jobs (>500 EE)

$24.1B in revenue
(nano-enabled)

Full Spectrum Value Chain – Canadian products and companies
E.g. Textiles, smartphones (Blackberry), cameras (DALSA), medical devices (Nicoya), drug delivery, paints and coatings (3M), automotive (Ford).

Optical thin-film solutions and services
Metallurgical nanotechnology 'nanovate' foils and foams
Biolatex – replace oil-based binders in paper ($100M IPO)
Global electronics manufacturing; design and services
Advanced materials, smart phones, security
Canada’s Nanotechnology Standards Committee Structure

**International**
- Nanotechnologies ISO/TC229 & IEC/TC113
  - Technical Committees (TC) & their Working Groups (WG)
- Standards Council Canada (SCC)
- CSA Group SCC Mirror Committee (SMC)
  - (multiple interests & expertise)
  - Facilitated by CSA Group

**National**
- ISO and IEC: Global Standardization
  - CSA Group Strategic Steering Committee (SSC)
- SCC: Canada’s National Standards Body (NSB)
  - CSA Group: Canada Standards Development Organization (SDO)
- CSA Group Technical Committees:
  - Nano-Occupational Health & Safety TC
  - Cellulose Nanomaterials TC

**CSA Group Technical Subcommittees (TSC)**
- JWG1 TSC: Terminology / Nomenclature
- JWG2 TSC: Measurement / Characterization
- WG3 TSC: Health / Safety / Environment
- WG4 TSC: Material Specification
- TC113 TSC: Electrotechnical

National adoption & use

Facilitated by CSA Group (focused interests & expertise to input to, and participate in, the international standards work via the SCC Mirror Committee (SMC))
Nanotechnology Standards

- Canada’s voice in international standards for nanotechnologies is strong
- Adoption of ISO/IEC standards continues to enable trade and support commercialization
- Standards are voluntary, unless referenced in legislation
- Standards assist to verify compliance for buyer/supplier requirements
- International standards for nanotechnologies – over 50 published by ISO/TC229 and IEC/TC113
A Platform for Innovation

Our U15 research-intensive universities:

- Educate over **597,475** people annually
- Perform about **$8.5B** research annually (~27% of all research in Canada)
- Employ over **56,555** faculty (excluding clinicians)
- Are centered in communities where **62%** of Canadians live
- Offer English, French and bilingual campuses
- Exist coast-to-coast
Canada Research Chairs are a good pointer to where the strongest Nanotech research programs are to be found:

<table>
<thead>
<tr>
<th>Area of Focus</th>
<th>Total Research Chairs</th>
<th>Tier 1 Chairs</th>
<th>Tier 2 Chairs</th>
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<tbody>
<tr>
<td>Biomedical Engineering</td>
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<tr>
<td>Condensed Matter Physics</td>
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<td>11</td>
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<tr>
<td>Electrical and Electronic Engineering</td>
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<td>3</td>
<td>9</td>
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<tr>
<td>Inorganic Chemistry</td>
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<td>3</td>
<td>3</td>
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<tr>
<td>Materials Science and Technology</td>
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<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>11</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Physical Chemistry</td>
<td>10</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Physics</td>
<td>9</td>
<td>4</td>
<td>5</td>
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</table>
Canada has excellent infrastructures for nanotechnology – comparable to the best in the world

**University of Alberta**
- Research Chairs: 12
- Research Facilities:
  - NRC-NINT, NanoFab, MicroSystems Technology Research Initiative, Integrated Nanosystems Research Facility, Nano-Incubator

**McGill University**
- Research Chairs: 11
- Research Facilities:
  - McGill Institute for Advanced Materials, CLUMEQ High Performance Computing Centre, McGill Nanotools Microfab

**University of Montréal**
- Research Chairs: 7
- Research Facilities:
  - GCM Micro-Nanofabrication Lab; Centre de Recherche sur les Matériaux Auto-Assemblés (CRMAA)

**University of Waterloo**
- Research Chairs: 13
- Research Facilities:
  - Mike & Ophelia Lazaridis Quantum-Nano Centre, Waterloo Institute for Nanotechnology

**University of British Columbia**
- Research Chairs: 10
- Research Facilities:
  - AMPEL Nanofabrication Facility (ANF), Microsystems and Nanotech Research Group (MiNa)

**McMaster University**
- Research Chairs: 5
- Research Facilities:
  - Centre for Emerging Device Technologies (CEDT), Brockhouse Institute for Materials Research (BIMR), Canadian Centre for Electron Microscopy (CCEM), Centre for Research in Micro- and Nano-Systems (CRMNS)

**University of Toronto**
- Research Chairs: 8
- Research Facilities:
  - Centre for Advanced Nanotechnology, Emerging Communications Technology Institute, Smart & Adaptive Polymer Lab

**Western University**
- Research Chairs: 5
- Research Facilities:
  - Western Nanofabrication Facility, Bionanotechnology Research Lab, Surface Science Western
Nano Ontario

Nano – Impacting – Ontario

Serve Members

*Nano Ontario* is a not-for-profit organization that represents the interests of members from academic, government, industrial, and financial sectors in the development of nanotechnologies in Ontario.

Build Capacity

Members work together to raise the profile, increase the research, build the investment and drive economic returns from nanotechnology in the province and across Canada.
2 FEI Titans 80-300 with CEOS-designed hexapole-based aberration correctors:

I) High-resolution (0.1 eV) monochromator (Gatan 865); sub-Å spatial resolution

II) Cryo capability; in-situ laser system; ex-situ environmental cell; better than 0.25 eV resolution to probe chemical bonding

http://ccem/index.php
The **Toronto Nanofabrication Centre** (TNFC) offers global research leadership by providing access to state-of-the-art nanofabrication facilities, collaborative research networks, advanced educational opportunities and information exchange events for registered users and clients.

The **Centre for Advanced Nanotechnology** (CAN) is at the forefront for developing the key enabling technologies for nanoelectronic and nanophotonic applications.

The **Ontario Centre for the Characterisation of Advanced Materials** (OCCAM) allows researchers ready access to state-of-the-art surface analytical equipment and electron microscopic techniques as well as the related expertise, thereby providing enabling information for the many disciplines involved in advanced materials research.

The **Centre for Biocomposites and Biomaterials Processing** (CBBP) is working on the development of next generation energy efficient lightweight performance nanomaterials for industrial applications including aerospace, automotive, bio-medical and electronics, by utilizing primary and secondary natural resources such as forest- and agro-residues.
Key Universities – Research Facilities

Mike & Ophelia Lazaridis Quantum-Nano Centre

Waterloo Institute for Nanotechnology
Institute for Quantum Computing

Molecular Beam Epitaxy (MBE) Facility

Metrology

One building, two institutes
Waterloo Institute for Nanotechnology
Institute for Quantum Computing

$30M shared facilities
QuantumNano Fabrication Facility
Metrology
Surface Science Western: Canada’s Premier Surface and Materials Analysis Facility

Contacts: biesingr@uwo.ca and info@surfacesciencewestern.ca

Western Nanofabrication Facility: an Open User Facility

Contacts: flagugne@uwo.ca and nanofab@uwo.ca
Nano Ontario

7th ANNUAL CONFERENCE
NANOBIO & SUSTAINABILITY

hosted by the University of Guelph
@ the Delta Guelph
November 10 & 11, 2016

For more information on registration and abstract submission please see
www.NanoOntario.ca
Nano Ontario Events

NANOFACILITIES FOR EMERGING TECHNOLOGIES
Industry-University Showcase
Mike & Ophelia Lazaridis Quantum-Nano Centre
University of Waterloo, Waterloo, Ontario
May 13th, 2016

Industry-Academia Panel 2016

“Commercialization of Sustainable Nanotechnologies & Forging Sustainable Industry-Academia Partnerships”

Panelists:
Richard Berry
Vice-President, Technology and CTO
Celluforce

Phil Whiting
President and CEO
Mirexus Biotechnologies

Darren Anderson
Chief Communications Officer and VP Regulatory
Vive Crop Protection

Sabrina Leslie
Department of Physics
McGill University

Gilbert Walker
Canada Research Chair, Department of Chemistry
University of Toronto

Moderator:
Peter van Ballegooie
VP Marketing and Business Development
EcoSynthetix

100 participants
Industry exhibits
Panel of Collaboration
Key to Technological Success
Networking Opportunities
NanoOntario commissioned Board Member Robert Crawhall to conduct a study and prepare a report for Industry Canada and Environment Canada on nanotechnology industry in Canada. The purpose was to gain a better understanding of industry involvement and intentions in nanotechnology development and application in Ontario.

**Nanotech companies were identified in 10 industry sectors and are concentrated in 3 major regions** (Greater Toronto-Hamilton Area, Ottawa Region, and Kitchener, Waterloo & Cambridge Region).
Waterloo Entrepreneurship

University of Waterloo Nanotechnology Startups

Making counterfeit goods a thing of the past

Gardening made simple

Allergy testing made safe, simple and certain

Transparent digital screens

NDS is the only company in the world that can batch manufacture HR AFM tips and cater to the entire global market on its own

NanoQuan makes Nanocomposites - Better

The future of risk-free surgeries

Nicoya uses nanotechnology to build the tools that scientists need to make their next big discovery

Implantable artificial kidneys for three million patients with End-Stage Renal Disease (ESRD)

Extrude. Experiment. Explore

Know your body, control your health

Canada
Handheld, blood-testing platform for HIV and other infectious and non-communicable diseases

Pilot production line capable of producing high volumes of organic light-emitting diode (OLED) lighting panels.

Committed to developing products and technologies which increase farm efficiency & productivity, as well as reducing the environmental impact pesticide applications have on our world.

Developed a lab-free molecular diagnostic platform with a 20 minute time-to-result, which enables on-demand, near patient molecular testing, empowering clinicians to make treatment decisions and provide peace of mind for their patients at the time of first consultation.

Develops a product called QuantumFilm, which is a breakthrough imaging-sensing technology that will replace silicon.

Offers biobased binders that find applications in biopackaging and green house industry, horticulture, hospital disposable, electronic packaging.

A leading Cleantech manufacturer of NCell™ Natural Fiber reinforced thermoplastics for injection molding and extrusion application.

Licenses its process technologies and manufactures products based on its core intellectual property: electroplating / electroforming of nanocrystalline metals.
Ontario-Jiangsu Nanotech Innovation Centre

安大略江苏纳米技术创新中心
McMaster-Jiangsu Collaboration in Water and the Internet of Things

Delin Environmental Tech
Water quality monitoring

China Center of Internet of Things (CIT)
Micro/nano sensors, networks, and systems

Soochow University
Micro/nano sensors, surface modification
Nanomedicine

CAS Institute of Microelectronics, Nanoelectronics & Sensor Networks
IoT, Nanomedicine