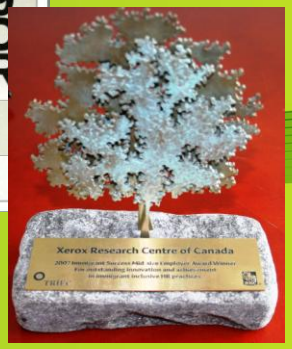
Materials Research @ Xerox Research Centre of Canada

Hadi Mahabadi

VP and Director

June 7th, 2010

UBC, Okanagan



Picture taken in 2006

June 2010 – ??????? Patents

Outline

- Introduction
- Materials R&T Trends
- Nanotechnology and Application at XRCC
- Smart materials and Application at XRCC
- An example of R&D effectiveness (Do more with less)
- Summary

Xerox Research Centers

Xerox Research Centre of Canada
Mississauga, Ontario, Canada

Xerox Research Centre Europe
Grenoble, France

Palo Alto Research Center, Inc
Palo Alto, California, USA

Webster Research Centers
Webster, NY, USA

Xerox Research Centre of Canada

Begins operation – 1974

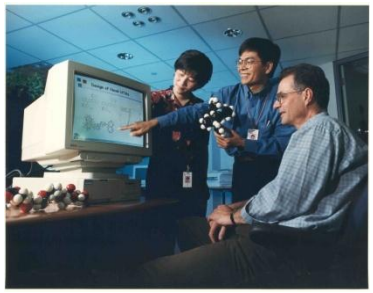
Moved to this site in Sheridan Science and Technology Park - 1980

Features 120,000 sq.ft state-of-the art research labs and advanced research pilot plant

Xerox Research Centre of Canada

Mission: Providing novel materials technology in support of Xerox supply business and for creating new businesses

Toner, ink, key components, advanced media and specialty materials

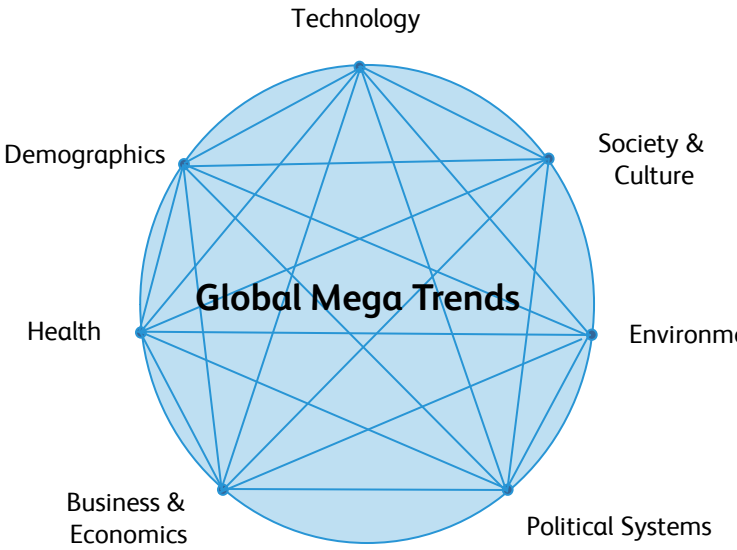


Competencies : Materials Design, Materials Testing and Manufacturing Process Design

Output: Enabling materials, advanced manufacturing processes, Intellectual Property


THE WORLD IS
CHANGING
WORLD POPULATION
4 births per second
MOBILE PHONE
37 sold per second

Top 10 Mega Trends Toward 2020



Top 10 Mega Trends

1. **Ageing** - More off- shoring & outsourcing and different perception of immigration
2. **Globalization** – expanded flows of people, capital, goods& services, information, technology and culture. We will have a world of Nations and Regions
3. **Technology development** – in 2020, computers will be 200X faster and have 1000X more memories Nanotechnology will will be the general term of technology.
4. **Prosperity** – larger groups in formerly developing countries growing more prosperous. Middle class will grow in Russia, China, Brazil by 85 %,40 % and 50 % in the next 10 years.
5. **Individualization** – customers are increasing their demand for individual and personalized products, more employee turnover & demand for employee individual attention.
6. **Commercialization** – shorter time to market and faster growth for new products
7. **Health and environment** – growing sector, more resource will be allocated to it
8. **Acceleration**- it is not enough to be change ready. Change oriented will be the norm. Speed & flexibility are other demands.
9. **Network organizing** – challenges the way of thinking and traditional instaurations
10. **Urbanization**- 3.9B new people will living in urban areas

Materials R&T Trends

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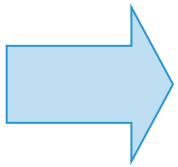


Industry Trends for Chemistry and Materials Science& Engineering

S&T Trends

1. Nanotechnology
2. Smart Materials
3. Greener chemistry & Engineering

Operation trends

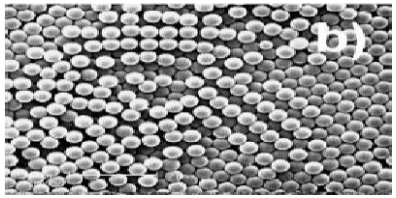
1. Do more with less

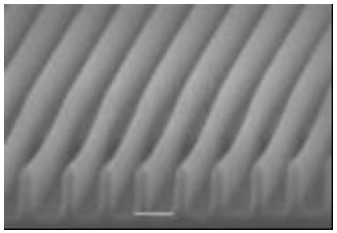
Why Nanotechnology

Small size → powerful properties

- High surface to volume ratio → more powerful catalysts and more sensitive sensors
- Quantum effects → Quantum dots

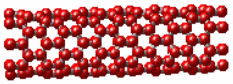
- Smaller size devices → molecular electronics





Controlled assembly of materials/devices/systems:

- Imparts new properties/functions
- Enables versatility of design and performance
  - Light-weight materials that are stronger than steel
  - Carbon-based materials that are more conductive than copper



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Nanotechnology at XRCC

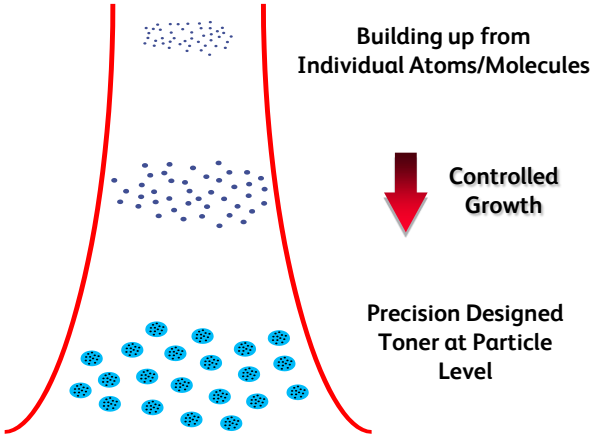
EA Toner Technology → Current Line of Business

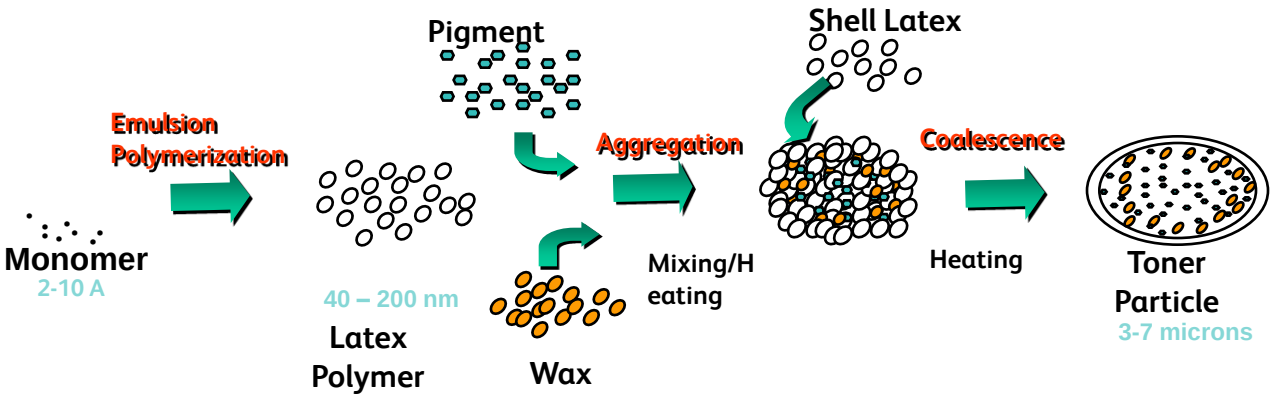
Market needs:

- Environmentally friendly toner technology that enables high quality document with less toner

The Solution:

- **Bottom-up assembly process** to make toner particles → **"EA Technology"**
  - Precision particle design with control of morphology & structure
  - Toner particles of smaller size, tunable shape, and narrow size distribution
  - Enviro-friendly toner (less toner per printed page) and toner manufacturing





Nanotechnology at XRCC

EA Toner Technology → Current Line of Business

Enables sharper images

Reduces Xerographic process complication

Reduce energy and toner usage

Saves over 70 % of energy for printing page

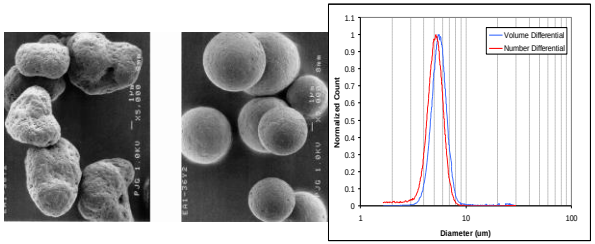
Project started in mid 1990's, commercialized in 2001

First manufacturing of EA toner located in Mississauga

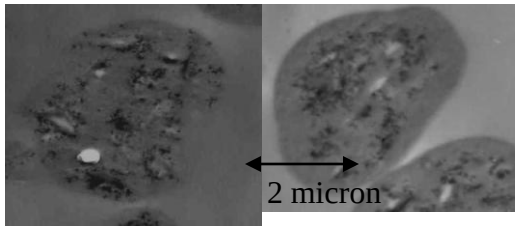
Over 20 Xerox products are using it.

Next Gen EA was launched in May 2008

EA Technology awarded in 2005 , 2006 & 2007

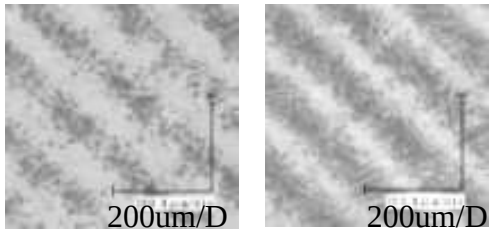


TEM Photograph of EA Toner



No Shell EA with Shell

Line image reproduction on Rough Paper



Conventional Toner E/A Toner

Why Smart Materials

Materials that change properties under stimuli like temperature, pressure, current,…

- Future smart devices need smart materials
- Enables simpler and smaller devices/HW

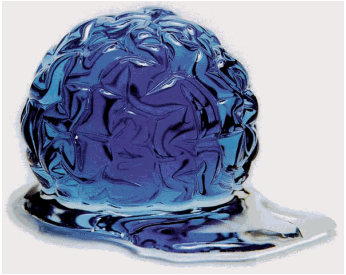
Controlled performance of devices/systems:

- Imparts new properties/functions for different conditions
- Enables versatility of design and performance
  - Different properties under different conditions

Several Examples:

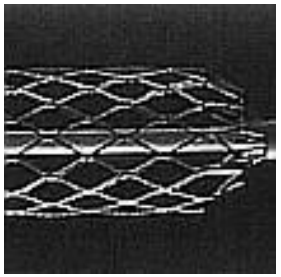
- Shape Memory
- Photochromic
- Piezoelectric
- Sensors – light, temperature, moisture
- Magneto-rheostatic
- Electrorheostatic
- Self healing

Variable Viscosity Fluids



Source: www.cs.ualberta.ca

Shape Memory



Stent for veins (Ni/Ti alloy)
Source: www.nitinol.com

Photochromic Materials

Source: wikipedia

Source: www.sfu.ca

Sensors

Source: interactive architecture.org (MIT)

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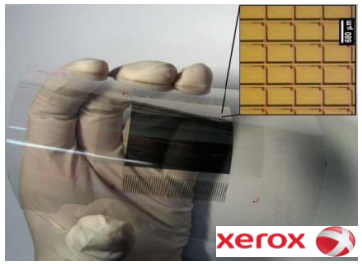
Smart Materials at XRCC

Organic Semiconductor → New Line of Business

Market needs:

- Light weight, low cost and flexible electronics



The Solution:

- **Printable organic electronic materials**

From current Si semiconductor and batch Photo lithography process

→

to organic electronics and continuous deposition process

Silicon-based transistors

→

Printed organic transistors

Material Requirements for Printed Electronics

Semiconductors

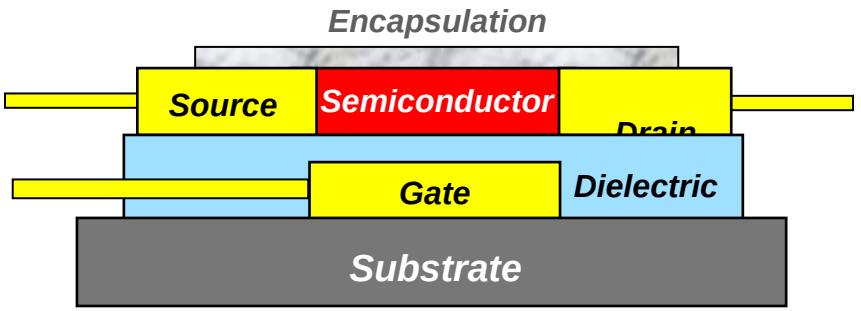
- Printable on various surfaces
- Air stable
- High field effect mobility
- Low processing T that enables high throughput

Conductors

- High conductivity
- Low processing temperature
- Printability on various surfaces

Dielectrics

- Pinhole free for low gate leakage
- High dielectric constant
- Compatible with semiconductors



Thin-Film Transistor—
the key building block for ICs

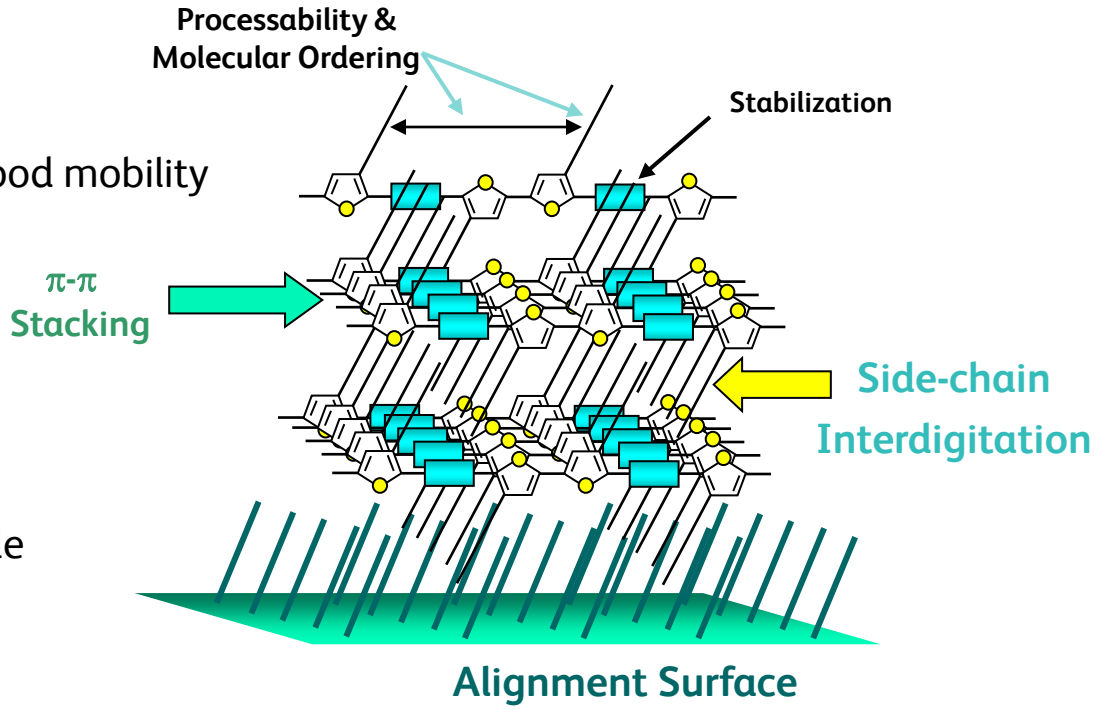
Xerox Printable Semiconductors

Molecular design to self assemble

Provides air stability

Molecular alignment to enable good mobility

Low-annealing temperature



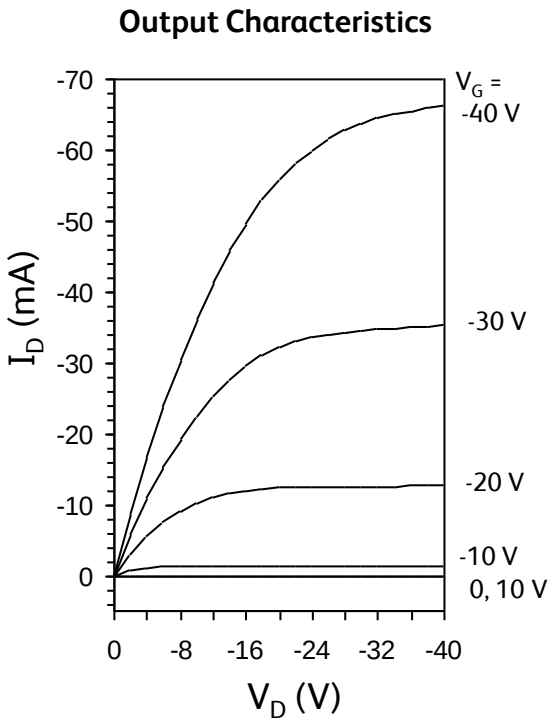
Ink design

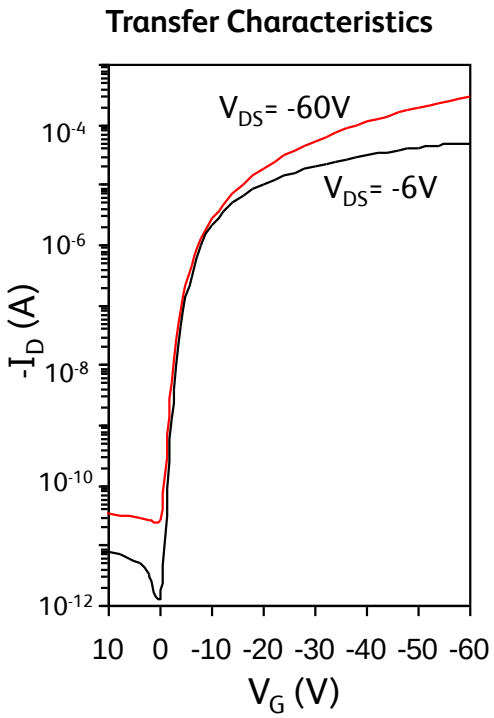
Self assembly provide nanoparticle

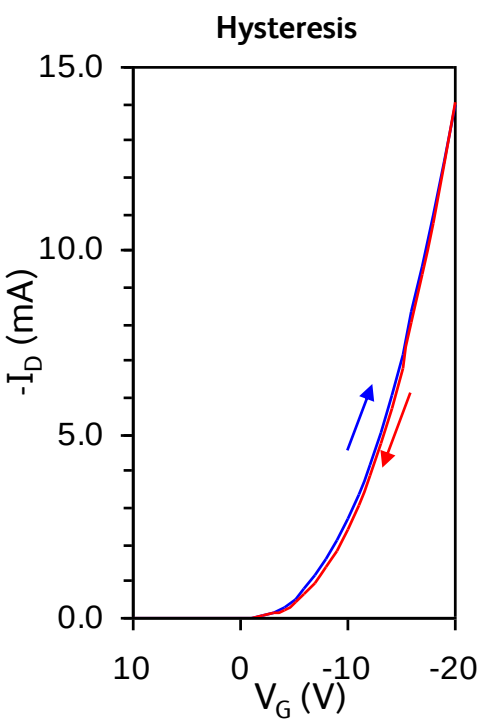
Stable ink dispersion for jetting

Polymer Preprints, 44, 321 (2003)

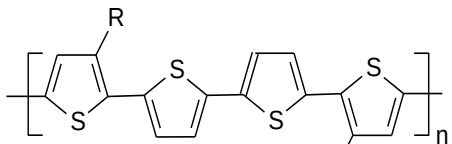
FET Performance of PQT-12







FET mobility ($cm^2/V.s$)	
Linear regime	0.05 - 0.18
Saturated regime	0.08 - 0.2
Current on/off Ratio	$10^6 – 10^8$



PQT

Phys. Rev. B, 70, 115311 (2004)
Adv. Mater., 17, 1141 (2005)

R&D Effectiveness

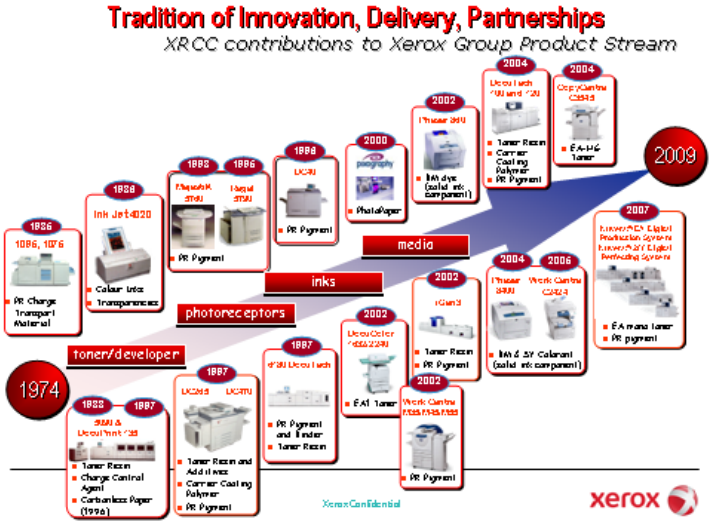
XRCC An environment that promotes innovation / productivity

Source of Innovativeness/Productivity

- Create an environment that encourages creativity and commercialization
- Customer driven R&D initiatives and use of DfLSS tools
- Developed deep core competence required to conduct research and deliver results (De-risk technology to enable technology pull vs push)
- Use diversity, multi-disciplinary teams and collaboration from different disciplines to create greatest innovation and faster delivery
- Use of Discovery network
- Use of continuous improvement and learning

Degree of Innovativeness/Effectiveness

- Increased inventiveness of centre by 30 % over last 4 years
- Generated a total of 1239 patents with 130 patentable Invention Disclosures/year
- 950+ publications
- ~5 new Technologies/year delivered to market

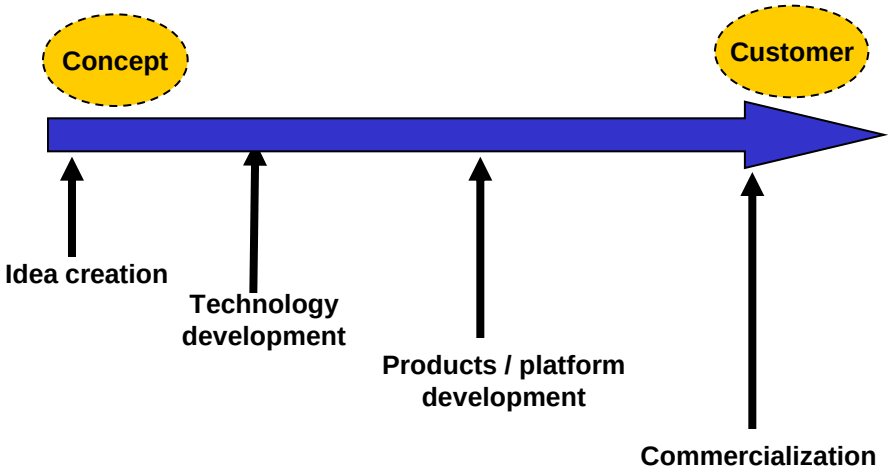


Xerox Research Centre of Canada

Discovery Network

Leverage creativities and ideas from organizations within and outside the research centre and Xerox:

- Hire diverse and talented researchers
- Use multi-disciplinary teams and matrix management approach
- Form partnerships with universities and other R&D organizations and industries
- Use open innovation concept partnerships
  - NINT partnership



XRCC / NINT Partnership

- XRCC / NINT and Government of Alberta formed $4.5 M for three years Partnership on nanotechnology R&D
- This partnership will accelerate nanotechnology innovation / commercialization in the areas that are beneficial to all partners
  - XRCC will gain access to NINT's state-of-the-art characterization and fabrication equipment
  - NINT will hire 6-10 researchers as additional resources for this partnership
  - Training opportunities and Knowledge injection to XRCC and NINT
  - NINT and XRCC directors will manage this partnership

XEROX · NRC·CNRC National Institute for Nanotechnology · University of Alberta · Alberta Government of Alberta

Summary

- World changing in significant ways for the next 20 years
- Nanotechnology, smart materials and Greener materials/processes offers significant future opportunities
- Xerox Research Centre of Canada has been applying nanotechnology, smart materials and Green chemistry to advance Xerox core business and to create new businesses
- Xerox Research Centre of Canada applying management approaches and tools to maximize its effectiveness
  - Nanotechnology enabled toner materials have been developed and successfully introduced to market
  - Smart materials enabled transient printer are being developed for creating new business opportunities for Xerox
  - R&D effectiveness is a competitive advantage for future R&D organization

Thank you