Opportunities for

Canadian Researchers

in Singapore's Science and Engineering R&D Network

Canada

THE CANADIAN TRADE COMMISSIONER SERVICE

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Prepared by:

THE CANADIAN TRADE COMMISSIONER SERVICE

In cooperation with:

Data Storage Institute
Institute for Infocomm Research
Institute of Chemical and Engineering Sciences
Institute for High Performance Computing
Institute of Materials Research and Engineering
Institute of Microelectronics
SIMTech
Science and Engineering Research Council
Nanyang Technological University
NUS National University of Singapore

Government of Canada
High Commission of Canada

Gouvernement du Canada
Haut-commissariat du Canada

There is no better time for Canadian scientists and researchers to seek out R&D collaborations in Singapore. Singapore has embarked on an ambitious research and innovation strategy and is backing up its plans with significant funding commitments.

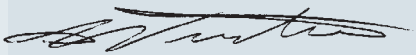
As one president of a major Canadian university remarked during a recent visit to Singapore, “This kind of government investment in research, along with its willingness to partner, cannot fail to draw in top international science... When I consider what the future holds, I am inclined to point to Singapore as the example that we should be following.”

We see tremendous opportunities for Canadian research institutes, universities, or the private sector to leverage on Singapore’s research infrastructure and manpower. If you are looking for a committed research partner who has access to considerable funding and state-of-the-art equipment and facilities, you should consider Singapore.

We have prepared this publication to outline Singapore’s core research competencies in applied sciences and engineering to help you determine whether there might be a good fit. We can also facilitate introductions with our network of contacts in Singapore’s S&T community to get you one step closer to creating synergies and advancing research programs.

We wish to thank Singapore’s Science and Engineering Research Council and its seven research institutes, as well as Nanyang Technological University and the National University of Singapore for their contributions to this publication. Their generous cooperation is a clear indication of their interest to develop closer links with Canada’s science and innovation network.

Canada and Singapore have the people, technology, infrastructure, and climate that foster innovation. Working together will advance our respective innovation agendas and contribute to our nations’ knowledge- and innovation-driven growth and prosperity.



Alan Virtue
Canadian High Commissioner (Singapore)

Canada

Science and Engineering Research Council

The research institutes under the Science & Engineering Research Council of Singapore's Agency for Science, Technology and Research (A*STAR) have a wide spectrum of capabilities and research expertise in physical sciences and engineering. These are directly relevant to the electronics, information science, communications and media, chemicals and engineering disciplines, and support research areas requiring multidisciplinary solutions such as energy, nanotechnology and medical engineering & technologies.

Over the last ten years, A*STAR and Canadian research agencies such as the National Research Council (NRC) and its counterparts in the provinces of Ontario and Alberta have supported programs that have laid much of the groundwork needed for relationship-building between Singapore and Canadian research institutions, industry and universities, and led to joint projects which represent an excellent start in generating useful research outcomes for both countries. A*STAR looks forward to the continuing development of these collaborative partnerships with Canadian companies, research institutions and universities.

These may take on several forms, ranging from joint projects, attachments of research or postdoctoral staff as well as workshops and seminars in areas of common interest.

We would like to thank the Canadian High Commission in Singapore for sharing the same vision for international cooperation by putting together this publication. The showcase of Singapore's Science and Engineering R&D strengths and core competencies is an excellent next step to forging new partnerships and strengthening existing bonds between research institutions, universities and companies in both countries.

Prof Chong Tow Chong
Executive Director
*Science & Engineering Research Council. A*STAR*

OVERVIEW

Singapore regards research and development (R&D) as the foundation upon which to build its intellectual and knowledge capital and ultimately its economic competitiveness. Singapore has concentrated its R&D resources to develop core research capabilities that complement its key industrial clusters, namely: electronics, engineering, chemicals, information communication technologies (ICT), and biomedical sciences.

Recent developments in Singapore's S&T network, including a doubling of its public sector R&D funding for 2006-2010, will offer opportunities for Canadian researchers seeking out R&D collaborations.

RECENT DEVELOPMENTS:

In 2005, the Singapore government announced a doubling of its public sector R&D funding to S$11.5 billion (C$8.5 billion) over the next five years (2006-2010). Of this, S$5 billion will be allocated to the new National Research Foundation (NRF) for long-term strategic programs, S$5.4 billion to the Agency for Science, Technology and Research (A*STAR) for applied, mission-oriented R&D, and S$1.05 billion to the Ministry of Education for academic research.

These resources will be concentrated in Singapore's strategic R&D disciplines (noted above), as well as in new areas, including: interactive & digital media and environmental & water technologies. Within these areas, applied research, closely integrated with industry development and investment promotion, will still be the predominant focus; however, Singapore will also increase its funding for investigator-led research primarily at the universities.

Singapore benchmarks its R&D efforts against the smaller advanced European economies and is working towards a GERD (Gross Expenditure on R&D)/GDP ratio level closer to economies like Sweden (4.27% of GDP), Finland (3.46%), Switzerland (2.57%), and Denmark (2.53%).

Singapore's goal is to raise GERD to at least 3% of GDP by 2010. Singapore's GERD has been increasing steadily and reached 2.25% of GDP in 2004 (latest figures), up from 0.85% in 1990. Recent increases in expenditure have been led by the private sector, whose R&D spending grew by 24% in 2004. This trend demonstrates Singapore's evolution into a knowledge-based economy and an increasingly significant potential partner for Canada's research and innovation network.

SINGAPORE'S S&T INFRASTRUCTURE:

At the centre of Singapore's S&T infrastructure is the Agency for Science, Technology and Research (A*STAR). A*STAR, under the purview of Singapore's Ministry of Trade and Industry (MTI), is the Singapore counterpart agency to Canada's National Research Council. A*STAR plays a central role in setting the thematic priorities for public sector R&D, developing the national base of postgraduate research manpower, investing in physical research infrastructure, and facilitating the commercialization of intellectual property (IP).

Four units have been established under A*STAR: two research councils, the Biomedical Research Council (BMRC) and the Science & Engineering Research Council (SERC), which support, direct and stimulate research in their respective areas; the A*STAR Graduate Academy (A*GA), which implements A*STAR's scholarship programs to enhance human capital development; and Exploit Technologies Pte Ltd, a wholly-owned subsidiary of A*STAR that manages IP and facilitates technology transfer.

There are twelve research institutes (RIs) under A*STAR, seven focusing on applied science and engineering R&D (under SERC) and five on biomedical sciences R&D (under

BMRC). This publication focuses on opportunities for Canadian researchers in Singapore's science and engineering research disciplines. R&D in biomedical sciences and defence are not captured in this publication.

In addition to the RIs under SERC, the National University of Singapore (NUS) and Nanyang Technological University (NTU) also engage in science and engineering R&D in multi-disciplinary areas. The two universities are home to some of Singapore's top talent and state-of-the-art research facilities and equipment as well as their own technology transfer offices to commercialize IP. NUS and NTU receive R&D funding from the Ministry of Education, A*STAR, and other government bodies.

OPPORTUNITIES FOR CANADIAN RESEARCHERS:

Singapore recognizes that international collaborations are key to advancing research excellence. Therefore, as research programs expand due to the increase in funding, opportunities for international collaborations will grow. Canadian researchers will have the chance to tap into large, well-funded programs supported by top talent, facilities and equipment.

Singapore's decision to include the new areas of interactive & digital media and environmental & water technologies within its core strategic R&D disciplines will also present new opportunities for research partnerships as these sectors are more closely aligned with Canada's own research interests and competencies.

Singapore's increased commitment to basic research also translates into greater opportunities for Canadian institutions (and particularly universities) that are seeking out collaborations in upstream research areas.

In addition, Singapore places a great emphasis on creating economic value from its IP. In this regard, there are opportunities to share ideas and information on our respective commercialization programs and initiatives and ultimately find new ways to bridge the gap between mind and market.

The one-page summaries in this publication profile the specific core physical sciences and engineering R&D competencies within SERC's RIs, NTU and NUS, and those that offer the greatest opportunities for research collaborations. In general, Canadian researchers will find the greatest opportunities in the following broad areas:

- Electronics (data storage, microelectronics, and semiconductors);
- Engineering (manufacturing technologies, materials sciences, environmental technologies)
- Chemicals (synthesis, catalyis, polymer, and process technologies); and
- Infocomm & Media (communications, information science, and media technologies);

If you are interested in exploring opportunities for R&D collaboration in Singapore, please contact our office at the following coordinates. We would be pleased to help facilitate introductions.

High Commission of Canada
One George Street, #11-01
Singapore, 049145
Phone: (65) 6854-5900
Fax: (65) 6854-5915
Email: SPORE-TD@international.gc.ca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Data Storage Institute (DSI)

www.dsi.a-star.edu.sg

Data Storage Institute

DSI spearheads R&D in next generation data storage technologies. DSI has core competencies in magnetic, optical and network storage technologies and is equipped with state-of-the-art facilities for advanced materials and network storage R&D as well as system design and prototyping. Originally established in 1992 as the Magnetics Technology Centre, it was renamed DSI in 1996 and now has about 175 staff.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

- *Spintronics, Media, and Interfaces*
  nano-spintronics; magnetic reading head, materials & processes; magnetic writing head; recording media & media magnetics; media overcoat materials, nano-surface conditioning & flyability of advanced disk media; tribology, slider & suspension technology & low-flying height technology; burnishing slider technology; recording systems & physics; modeling & system optimisation; nano-metrology instrumentation & equipment; MRAM; data storage beyond Tb/sq-in areal densities

- *Mechatronics and Systems*
  coding & signal processing; electro-magnetic system design & simulation; fluid dynamics; mechatronics; microsystems; motor; advanced servo; servo writing for recording systems

- *Optical Materials and Systems*
  optical data storage media and systems; non-rotational and non-volatile solid state memory; laser micro and nano-processing

- *Network Storage Technology*
  intelligent next-generation storage systems for efficient data & system self-management; storage for consumer & mobile applications; network storage transport protocol design, development & analysis; network storage modeling & simulation; promotion of network storage technologies applications in open environments; network storage system evaluation, testing, performance benchmarking & analysis

- *Integrative Science and Engineering*
  drives all DSI projects of an integrative science and engineering nature

PATENTS FILED/GRANTED:

156 and 114, respectively, since 1992.

RECENT DSI SUCCESS STORIES:

Numida – Developed by DSI scientists, NUMIDA is a sleek, compact, wireless personal storage device enabling anyone who requires mega storage on the go to transport data and instantly increase the storage capacity of their PC or laptop. It offers storage capacity of up to 60 GB and its wireless feature provides seamless connectivity without cable connection, unlike similar devices using USB ports.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

- Research collaboration with NRC's IMI on templated fabrication of large area nanostructured surfaces for magnetic, electronic, and biological applications (2003).

Institute for Infocomm Research (I2R)

www.i2r.a-star.edu.sg

Institute for Infocomm Research

I2R integrates R&D in information, communications and media (ICM) technologies to develop holistic solutions across the ICM value chain. Its research capabilities are in information technology and science, wireless and optical communications, and media analysis, processing and applications. I2R, an amalgamation of earlier research centres dating back to 1985, was formally established in 2002 and now has over 350 staff.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

- *Computing*
  cryptography; bioinformatics; data integration; information quality; system and network security; data mining; context-aware systems

- *Communications*
  radio transceivers; antenna; passive RFID system; UWB localisation; UWB imaging radar; MIMO; software reconfigurable systems; digital modems; smart antenna systems; fibre-based technology; optical communication networks; network architecture, protocols & middleware; communication architecture & signal processing

- *Media*
  efficient coding, compression, transmission, authentication for audio image, video; perceptual visual metrics; language processing; information extraction; indexing; media semantics retrieval; pattern analysis & recognition; computer vision; video understanding; speech processing & enhancement; discrete transforms, data fusion & optimisation; brain-machine interface; acoustic noise cancellation; multi-sensor signal fusion & source decomposition; wearable & pervasive computing

PATENTS FILED/GRANTED:

257 and 89, respectively, since 1993

RECENT I2R SUCCESS STORIES:

The Advanced Audio Zip (AAZ) technology – I2R researchers have developed AAZ, a scalable to lossless audio codec, which enables the compression of digital audio and offers quality superior to CDs. The contribution of I2R's AAZ to MPEG-4 SLS introduces a new dimension to audio archival, playback, download and streaming. Products and applications that incorporate SLS audio will cater to consumers who seek CD quality audio playback while minimizing storage requirements. SLS audio gives the user the flexibility to vary the audio quality playback and can be backward compatible with existing consumer electronic devices that are compliant with MPEG-4 AAC (Advanced Audio Coding) audio standard.

Innovative coding techniques – I2R researchers have developed a design to enhance data-rate for Wireless Personal Area Networks (WPANs). The enhancement achieves a data rate six times higher than the current IEEE (Institute of Electrical and Electronics Engineers, Inc.) 802.15.4 standard and has been adopted by IEEE in the wireless standards (802.15.4b). With the enhanced capability in WPANs, portable and mobile computing devices are able to communicate and operate more effectively, without creating a bottleneck situation in complex applications. It is expected to boost the pervasiveness of mobile computing in daily activities.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

- MOU with TRLabs to jointly create, own and operate TechnoBridge, an R&D consortium aimed at building research capabilities in ICT, training graduates, developing new technologies and promoting collaboration between Canadian and Singapore industry partners (2000-2005).

- MOU with Simon Fraser University to encourage research collaboration in wireless computing technology and applications (2001-2003).


A*STAR
ICES
Institute of
Chemical and
Engineering Sciences

Institute of Chemical and Engineering Sciences (ICES)

www.ices.a-star.edu.sg

Institute of Chemicaland Engineering Sciences

ICES develops scientific knowledge, R&D manpower and technological capabilities to support Singapore's chemical, biomedical and process engineering industries. The research programme covers chemistry and chemical engineering science, combined with advanced analytical characterization and measurement to develop state of the art technology for the petrochemical, general chemical, fine chemical and pharmaceutical industries. ICES was established in 2002 and has almost 200 staff.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

- *Applied Catalyis (AC)*
  biomass to fuels & chemicals; natural gas derivatives; hydrogen production & storage; efficient PEM fuel cells; green chemistry (ultra low sulphur fuels, removal of VOC, CO2 abatement); asymmetric synthesis; polyolefin catalysis

- *Crystallization and Particle Science (CPS)*
  crystallization science & modelling (crystallization phenomena, controlling size, shape, form, purity and ability to formulate); formulation sciences (characterization of solid and liquid formulations, particle design, powder technology, interfacial phenomena, new technologies for novel formulations)

- *New Synthesis Techniques and Applications (NSTA)*
  asymmetric transformations; new synthesis tools; bioactive compounds; synthesis of functional polymers; process chemistry

- *Process Science and Modelling (NSTA)*
  advanced signal processing & chemometrics; analytical method development; mixing & fluid dynamics; reaction & molecular modelling; process level modelling & optimisation; waste minimization; advanced control applications; process supervision; decision support systems; planning, scheduling; supply chain management; implementation of large pilot scale studies; industrial demo projects; small scale manufacturing (up to 5 kg); chemical hazard assessment; risk & safety analysis

- *Chemical Synthesis Laboratory at Biopolis (CSL@Biopolis)*
  chemical sciences (chemical synthesis & chemical biology)

PATENTS FILED/GRANTED:

15 and 2, respectively, since 2002.

RECENT ICES SUCCESS STORIES:

Collaboration with Mitsui Chemicals Inc. – ICES is collaborating with Mitsui Chemicals Inc. and Singapore's Institute of Materials Research and Engineering (IMRE) to develop proprietary products and process technologies. The objective is to make new catalysts for the production of key petrochemical materials from light paraffins and optically pure fine chemical intermediates via C-C bond coupling reactions.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

None during this period.

Institute of High Performance Computing (IHPC)

www.ihpc.a-star.edu.sg

Institute for High Performance Computing

IHPC undertakes research in computational science and engineering and provides compute intensive resources and services to industry. Its areas of focus include advanced computing technologies, computational chemistry and electronic systems, and computational mechanics. IHPC is home to 2T flops of compute resources and a state-of-the-art 3D immersive visualisation centre. IHPC was established in 1998 and has almost 150 staff.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

- *Software and Computing*
  large-scale collaborative computing; scientific visualisation & virtual reality; computational intelligence
- *Intelligent Tool Design*
  tool room knowledge management; knowledge-based progressive die design & injection mould design; product design solutions; optimal process planning & NC code generating system
- *Materials and Industrial Chemistry*
  computational industrial chemistry; computational materials chemistry; SO fuel cell research
- *Electronics and Electromagnetics*
  electromagnetic CAE for micro & nanoelectronics & EMC modelling; EMC modelling & simulation
- *Solid Mechanics*
  strength & dynamic analysis; acoustic analysis; offshore technology; electronic packaging simulation; computational nanomechanics
- *Fluid Dynamics*
  indoor/outdoor air quality simulations; fire, smoke & combustion modelling; multiphase flow modelling; electronic cooling analysis; micro flow & MEMS simulation

PATENTS FILED/GRANTED:

27 and 11, respectively, since 2000.

RECENT IHPC SUCCESS STORIES:

Smoke Control Analysis – Using fluid dynamics software, IHPC carried out a study on smoke movement in a mass rapid transit (MRT) station. IHPC was able to provide an analysis of temperature, airflow distribution, smoke-soot concentration, and toxic gas dispersion in the station. Doing this within a virtual environment during the design stage reduced expensive trouble-shooting and re-working after installation.

Architectural Walkthroughs – IHPC has carried out projects involving hotel, villas and holiday resort virtual walkthroughs. These walkthroughs provide a natural way to gauge the look and feel of a structure, offering clients the opportunity to consider improvements and refinements before it is built.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

- Research collaboration with the University of Toronto to study reactions induced by minor chemical additions. Private sector partners were also involved in the project (1999-2001).
- Research collaboration with NRC's SIMS and ICPET on optimal design of new alloys as heater materials for filmstacks. Private sector partners were also involved in the project (2000).
- Research collaboration with NRC's BRI on multi-wavelength florescence in distributed parameter modeling and control of an up-flow anaerobic sludge blanket process for industrial wastewater treatment (2003).


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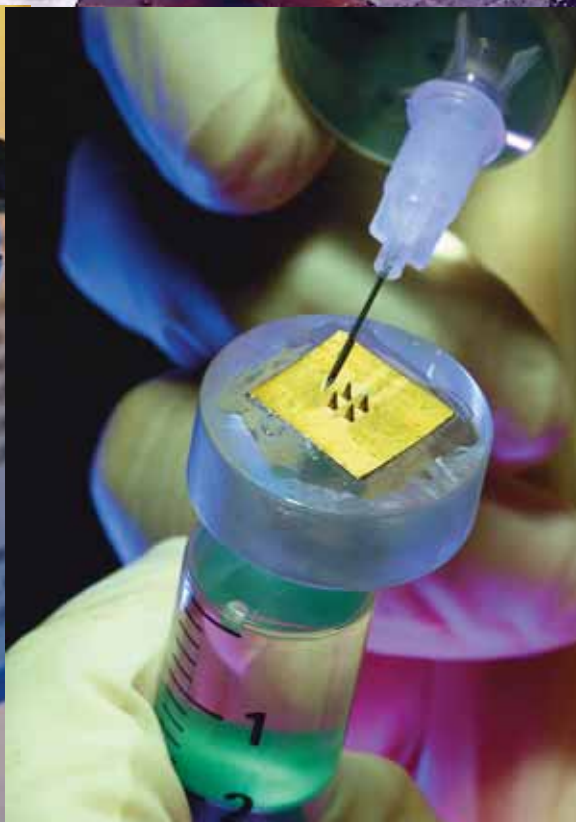


Institute of Materials Research and Engineering (IMRE)

www.imre.a-star.edu.sg

Institute of Materials Research and Engineering

IMRE undertakes research in selected fields of materials science and engineering, including optoelectronics, nanomaterials, chemicals, and polymers. It is committed to high-quality, extensive materials research and development to bring about the latest in innovation and technology. IMRE was established in 1996 and has close to 200 staff.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

Opto- and Electronic Systems

- opto-electronic materials & devices; plastic electronics; silicides & thin film metallurgy

Molecular and Performance Materials

- nano-structure materials; functional polymers; organic-inorganic hybrids; performance materials; polymer physics

Micro- and Nano-Systems

- sensor & actuator materials; micromachining & nano-patterning; interface science; process integration

Materials Science and Characterisation

- atomic layer epitaxy of low dimensional structures; nano-mechanical characterisation; materials analysis; materials theory & modelling

PATENTS FILED/GRANTED:

131 and 52, respectively, since 1997.

RECENT IMRE SUCCESS STORIES:

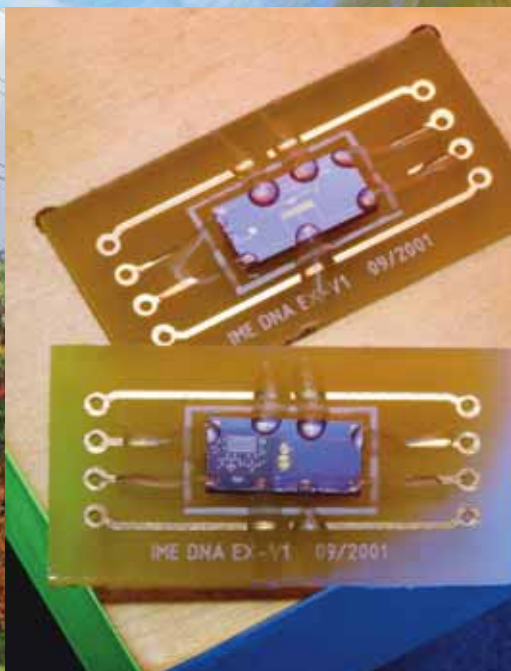
The Fluidlens – IMRE has developed liquid lenses that are expected to significantly impact applications in optical systems and precision instruments such as digital cameras and mobile phone cameras that require precise and compact focusing with zoom mechanisms. The lens is cheaper to make, has optical zooming abilities, and uses only a fraction of the space of most conventional lenses.

Magnetic Tagging – IMRE has invented forge-proof tags, where each tag has a unique identifiable characteristic and is extremely difficult to duplicate. The unique characteristics of each tag are based on the random patterns in the nano-magnetic materials embedded in the film. It is anticipated that these tags could be particularly useful for identifying counterfeit goods.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

- Cooperative research and commercialisation MOU with Alberta Research Council on ceramic membrane technology (2000-2005).
- Mutual non-disclosure agreement with Alberta Research Council on thin film polymer based photovoltaic cells and ceramic mixed conductor macro reactor for reformer applications (2000-2005).
- Research collaboration with NRC's ICPET on fabrication of mixed-matrix polymeric membranes containing zeolites and carbon for high selectivity gas separations (2001).
- Research collaboration with McMaster University on the development of tuneable multiple electrode, fabry perot and distributed feedback semiconductor lasers for optical communications (1999-2001).


INSTITUTE OF MICROELECTRONICS
11 SCIENCE PARK ROAD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IME DNA EX-V1 09/2001

Institute of Microelectronics (IME)

www.ime.a-star.edu.sg

Institute of Microelectronics

IME helps drive the growth of Singapore's electronics industries through R&D in semiconductor-based technology and solutions. IME's R&D covers the semiconductor technology chain, including integrated circuit design, wafer fabrication process technology, packaging and assembly, reliability testing and analysis, as well as micro-electro-mechanical-systems (MEMS). It also has a dedicated Bioelectronics & BioMEMS Programme to serve the biomedical industry and open up new opportunities for the semiconductor industry. IME was established in 1991 and has about 200 staff.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

- *Integrated Circuits and Systems*
  RFIC designs for communications and identification applications; RF device modeling; mixed-signal CMOS designs for sensors & bio-electronics applications
- *Semiconductor Process Technologies*
  si-based nano-electronics; heterogeneous materials integration for RF; opto & bioelectronics applications
- *Microsystems, Modules and Components*
  bioMEMS devices & bio-microfluidic chips; RF & optoelectronic systems in package; fine pitch wafer level packaging; advanced self assembly processes for packaging

PATENTS FILED/GRANTED:

200 and 117, respectively, since 1991.

RECENT IME SUCCESS STORIES:

Transistor Based Bio-Sensor Microarrays for DNA and Protein – IME has developed ultra-sensitive biosensors that can operate at the attomolar (10-18M) level, thereby reducing the time and cost for detection of DNA. The biosensors increase the sensitivity limits by more than 3 orders of magnitude over conventional methods using light-based scanner detection.

Integrated Read/Write RFID Tag with On-Chip Antenna – IME has developed the world's first RFID tag with on-chip antenna that has radio-frequency read and write capabilities. Compared to conventional RFID tags that are a few cm2 in size with long external antennas, IME's RFID chip measures less than 1mm2 with the antenna layered on top of the chip. IME's RFID chip also compares favourably with existing solutions as it has anti-collision and rewriting functions.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

None during this period.


FOSTEC

Singapore Institute of Manufacturing Technology (SIMTech)

www.simtech.a-star.edu.sg

SIMTech contributes to Singapore's industries through the generation and application of advanced manufacturing technology. SIMTech has carried out close to 700 projects with applications for electronics, semiconductor, precision engineering, automotive, aerospace, marine, and logistics sectors. SIMTech was established in 1993 and has about 300 staff.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

Forming Technology
- nanostructure processing & casting; sheet & bulk forming; powder & polymer micro-processing

Machining Technology
- ultra-precision machining of free-form optical surfaces; laser welding & deposition build-up; laser machining of electronics

Micro-joining and Substrate Technology
- micro-joining; micro-patterning; multi-functional substrate

Surface Technology
- hybrid composite coatings; sol gel functional coatings

Mechatronics
- ultra-precision motion; micro-manipulation; robotics systems

Precision Measurements
- optical & non-optical measurement; image processing

Manufacturing Execution and Control
- networked supervisory control; proactive performance management; embedded controller technology

Planning and Operations Management
- operations decision support; integrated planning & optimisation; virtual enterprise integration

PATENTS FILED/GRANTED:

127 and 13 respectively, since 1998.

RECENT SIMTECH SUCCESS STORIES:

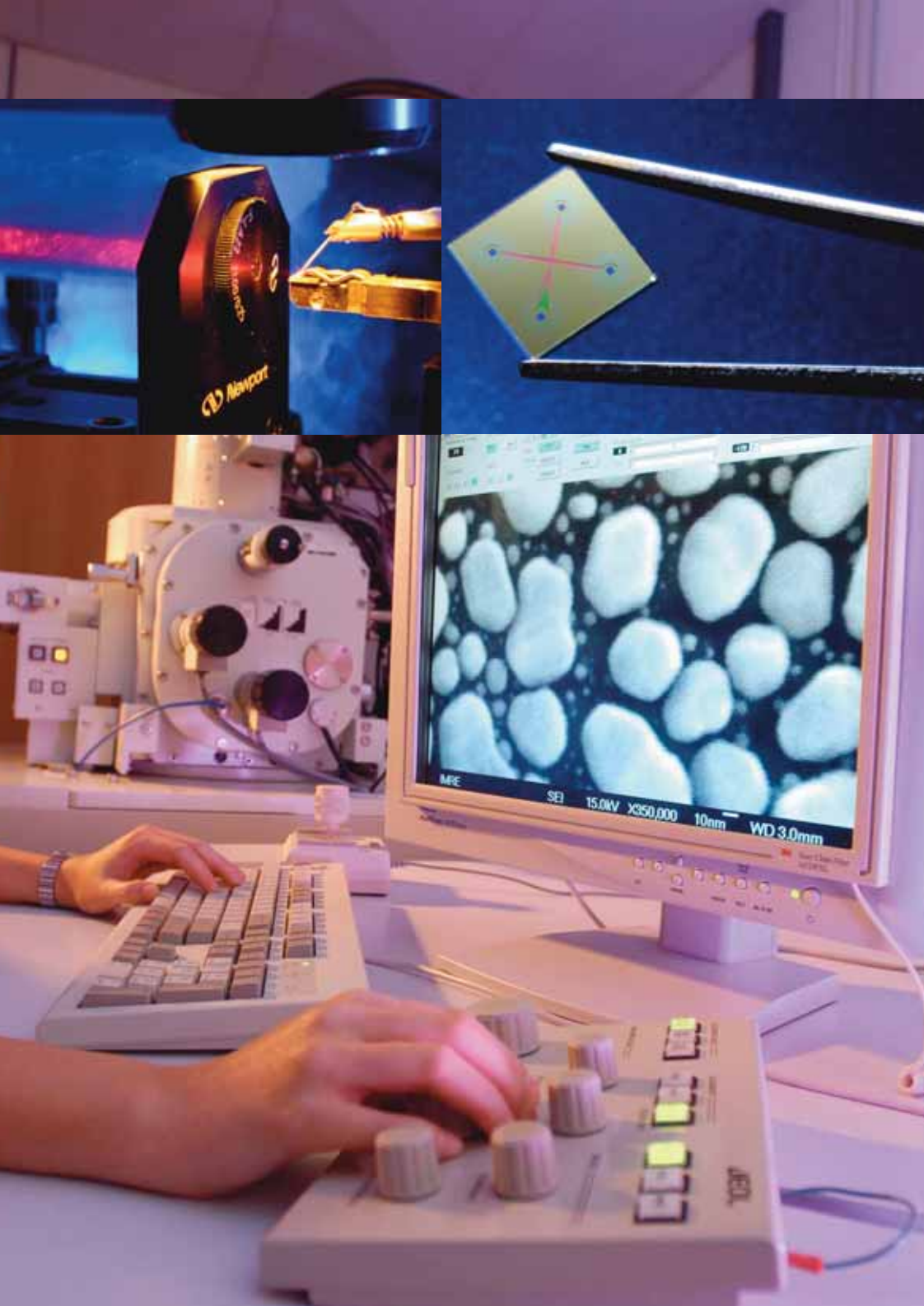
Vibration assisted cutting of optical surfaces - SIMTech has developed technology for cutting bare steel surfaces with single-point diamond tools to generate a surface mirror finish of below 8 nm Ra and a form profile accuracy below 0.15 um. The technology, which has been licensed to a local company, will enhance production of optical components (mould inserts, encoders with complex gratings, reflectors).

Low-cost digital level - SIMTech's contribution to embedded technology has led to the development of a low-cost digital level electronic surveying system. Relevant technologies for spin-off projects, such as tilt and angular sensors, have also been developed.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

- Research collaboration with NRC's IAR on Advanced Nano-coating Technology for Manufacturing and Aerospace Applications (2002 – 2005)

- Research collaboration with NRC's IMTI on Laser Micromachining of III-V Semiconductor and Glass Materials for Optical Switching and Opto-Electronic Applications (2002 – 2005)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Nanyang Technological University (NTU)

www.ntu.edu.sg

NTU was ranked 48th in the 2005 Times Higher Education Supplement of the world's best universities. NTU is within the upper echelons of the world's best science and tech universities, placing 26th among technology universities.

With a growing research profile, NTU is creating a name internationally for its work in fields such as advanced materials, biomedical engineering, clean energy and environment, computational biology, intelligent systems, nanotechnology and wireless and broadband communication.

In 2005, NTU was home to about 640 research staff, 1,800 research graduate students, and received over S$85 million (C$65 million) in research funding.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

- *Advanced Computing and Media Cluster*
  real-time rendering; virtual & augmented reality; interfacing interactive art & technology; bioinformatics; computational biology; computational nano-sciences/engineering; distributed computing & simulation; data & computational intensive info systems
- *Intelligent Devices and Systems Cluster*
  control systems; embedded systems; integrated circuits; robotics; human factors & ergonomics; computational intelligence & intelligent machines; sensor networks
- *Nanoscience and Nanotechnology Cluster*
  nanoelectronics; nanomagnetics & nano-optics; organic & molecular electronics; nanocomposites; energy & catalysis; nanobiotechnology

PATENTS FILED/GRANTED:

363 and 97, respectively, since 1995.

NTU RESEARCH CENTRES AND INSTITUTES:

NTU has 17 University-level and 45 Faculty-based Research Institutes & Centres (RICs) that encourage research in multi-disciplinary areas. The RICs cover a broad range of research disciplines ranging from environmental sciences to robotics, advanced media technology, and computational intelligence. The full list of RICs is available at: http://www.ntu.edu.sg/publicportal/about+ntu/research+institutes+and+centres.htm

RECENT NTU SUCCESS STORIES:

Smaller and Faster Chips – NTU researchers have developed a new nanotechnology process that enables smaller and faster computer chips to be built. This process is based on building computer chips made of an alloy that transmits data through light rather than traditional metal wiring.

Autonomous parking system – NTU researchers have modeled the human driving behaviour. While human drivers perform the desired manoeuvre, sensory data is recorded and fed into the system to automatically generate the rules that can be used to subsequently control the car.

COLLABORATIONS WITH CANADIAN INSTITUTIONS (2000-2005):

None at this time.

National University of Singapore (NUS)

www.nus.edu.sg

NUS was ranked 22nd in the 2005 Times Higher Education Supplement of the world's best universities. NUS is a comprehensive university providing quality education, engaging in high-impact research, and promoting entrepreneurship.

Moving forward in the global arena, NUS is building partnerships with universities worldwide and taking on strategic roles in global consortia that will continually strengthen synergies between the processes of creating, imparting, and exploiting knowledge.

In 2004, NUS was home to over 1,100 research staff, 5,400 research graduate students, and received about S$160 million (C$110 million) in research funding.

CORE RESEARCH CLUSTERS AND COMPETENCIES:

Nanoscience and Nanotechnology Initiatives (NUSNNI)

- nanomagnetics & spintronics; nanophotonics; nano/micro fabrication; nanobiotechnology; nanofiber science & engineering

Physical Sciences and Engineering

- environmental science & engineering; material science and engineering; polymer & molecular electronics; offshore research & engineering; synchrotron radiation facilities

InfoComm and Information Technology

- interactive & digital m; quantum technologies (quantum optics, trapped ions, optical lattices & cold atoms, solid state quantum technology, theory of quantum info & computation); info security &; complex networks & info transmission; wireless sensor networks; computational intelligence & autonomous systems; embedded systems; k; v; programming languages & databases

PATENTS FILED/GRANTED:

819 and 190, respectively, since 1997.

NUS RESEARCH INSTITUTES AND CENTRES:

NUS has 12 University-level and 70 Faculty-based Research Institutes & Centres (RICs) that encourage research in multi-disciplinary areas. The RICs cover a broad range of research disciplines ranging from Asia Research to Nanoscience & Technology, and Logistics to Marine Sciences. The list of University-level RICs is available at: http://nus.edu.sg/corporate/research/rsch_uni.htm
The list of Faculty-based RICs is available at: http://www.nus.edu.sg/corporate/research/rsch_depth.htm

RECENT NUS SUCCESS STORIES:

Overcoming Challenges in Facial Recognition – NUS researchers have developed a new approach to overcome the problem of varying illumination. They computed several images from one face under different lighting. The set of images was then used to train their algorithm to achieve a high level of performance in recognizing faces under changing illumination. The system has overcome head posture issues, minor changes in expression, and even recognizes a person with or without glasses.

Quantum Physics Helps Secure Data – NUS researchers at the Department of Physics have developed a class of new schemes that exploit the overhead data for ensuring secure encryption more systematically and efficiently. The procedure, called quantum state tomography, looks at the "structures" of communication data from all angles, using quantum physics to get a complete picture for analysis.

Collaborations with Canadian Institutions (current / ongoing):

- MOU with UBC to encourage research collaborations in areas such as ICT, Mechatronics, Industrial & Manufacturing Processes, Nanoscience & Nanotechnology, and Organic Electronics (2004 – ongoing).
- MOU with the University of Toronto to identify joint research and commercialization opportunities and to encourage academic exchanges and information/material sharing (1994 - ongoing).
- MOU with McMaster University to identify joint research and commercialization opportunities and to encourage academic exchanges and information/material sharing (1993 - ongoing).
- Research collaboration with NRC on "Semiconductor and Magnetic Nanostructures".
- Research collaboration with NRC on "Fabrication of mixed-matrix polymeric membranes containing zeolites and carbon for high selectivity".
- Research collaboration with NRC on "Intelligent Process Planning Systems for Optimal Multiple Axis CNC Machining".
- Research collaboration with the Clinical Research Institute of Montreal on "Methadone Analogues as Potential Analgesic Therapeutics".
- Several research collaborations with UBC in a diverse range of disciplines.

If you are interested in
exploring opportunities
for R&D collaboration in Singapore,
please contact our office at the
following coordinates.
We would be pleased to help facilitate introductions.

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