

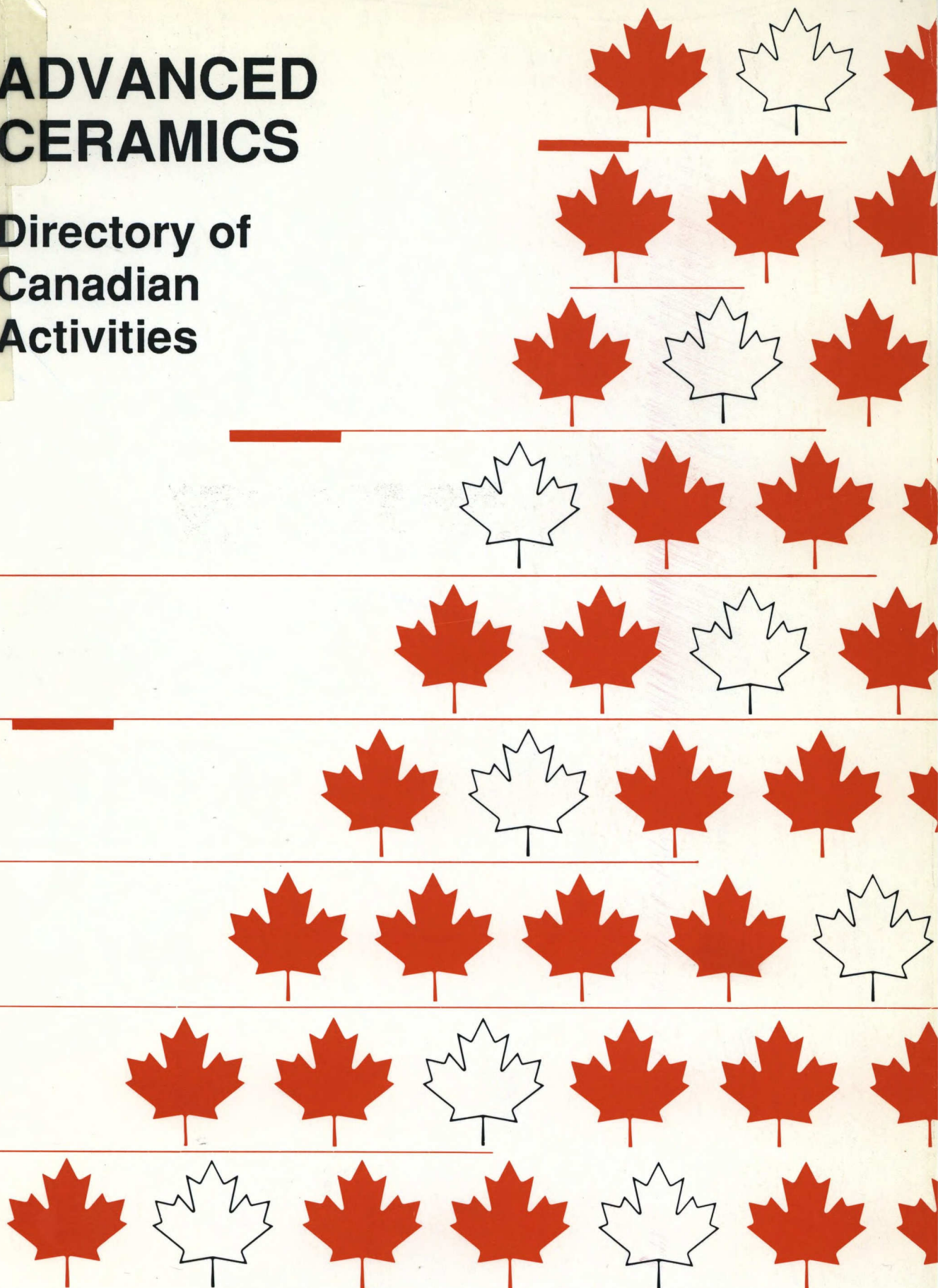
HD9595
.C2A3

1991 c.2

IC

ADVANCED CERAMICS

Directory of
Canadian
Activities



Compiled by

THE CANADIAN UNIVERSITY-INDUSTRY COUNCIL
ON ADVANCED CERAMICS

ADVANCED CERAMICS

DIRECTORY OF CANADIAN ACTIVITIES

compiled by

The Canadian University-Industry Council on Advanced Ceramics

for

Materials Branch
Industry, Science and Technology Canada

July 1991

(Également disponible en Français)

TABLE OF CONTENTS

PREFACE

EXECUTIVE SUMMARY

COMPANIES

Aastra Advanced Ceramics Inc.
Advanced Materials Engineering Centre
Alcan International
Applied Microelectronics Institute
Applied Physics Specialities Ltd.
B. M. Hi-Tech Inc.
Cancarb Ltd.
C-Axis Technology
Ceramics Kingston Inc.
Clayburn Refractories Ltd.
Com Dev Ltd.
Crystar Research Inc.
Datco Technologies Ltd.
EDO Canada Ltd.
Electrofuel Manufacturing Co. Ltd.
Hamilton Porcelains Ltd.
ICS Inc.
Inco Ltd.
JaCoat Co.
Jay-Em Ceramics
Kennametal Ltd.
Kennametal Inc., Macro Division
Lakeside Electronics Ltd.
The Laser Institute
Metal 7 Inc.
Montreal Carbide Co. Ltd.
MPB Technologies Inc.
Murata Erie N: A. Ltd.
National Coating Technologies Inc.
National Electrical Carbon Canada
Neosid (Canada) Ltd.
Northern Pigment Co.
Ontario Hydro

ORTECH International
Peacock Inc.
Polyceram Inc.
Powerlasers Ltd.
Pratt & Whitney Canada
Quality Hermetics Co. (1990) Inc.
Seastar Optics Division
Shaw Industries Ltd.
Sherritt Gordon Ltd. - WESTAIM
Standard Aero Ltd.
Syncrude Canada Ltd.
Tecrad Inc.
Vac-Aero International Inc.

ACADEMIC INSTITUTIONS

Concordia University
Dalhousie University
Ecole Polytechnique
Laval University
McGill University
McMaster University
Queen's University
Royal Military College of Canada
Technical University of Nova Scotia
University of British Columbia
University of Sherbrooke
University of Toronto
University of Waterloo
University of Windsor

FEDERAL GOVERNMENT ORGANISATIONS

AECL Research
Cameco Corporation
Canada Centre for Mineral and Energy Technology
Department of National Defence
National Research Council of Canada

PROVINCIAL R & D ORGANISATIONS

Alberta Research Council
Manitoba Research Council
Nova Scotia Research Foundation Corporation
Ontario Centre for Materials Research
Ontario Laser and Lightwave Research Centre

INDUSTRIAL ASSOCIATIONS

Canadian Advanced Industrial Materials Forum
Canadian Ceramic Society
Canadian University-Industry Council on Advanced Ceramics

APPENDIX

PROPERTIES & APPLICATIONS OF ADVANCED CERAMICS

TABLE I	-	Some current and future applications of advanced ceramics
TABLE II	-	Physical Properties of some Ceramic Materials
TABLE III	-	Corrosion Resistance
TABLE IV	-	Typical Properties of Abrasives
TABLE V	-	Relative Hardness
TABLE VI	-	Ceramic Sensor Materials
TABLE VII	-	Applications of Ceramics in Micro-electronics
TABLE VIII	-	Other Applications of Advanced Ceramics

PREFACE

Interest in Advanced Ceramic Materials has gained considerable momentum in Canada over the past few years as users, and potential users, of these materials continue to evaluate and exploit their advantages in daily operations. The broad spectrum of advanced ceramics, from cutting tools and fibre optics to turbo-chargers and bio-active materials, have the potential to improve existing products and manufacturing processes with significant economic returns. Countries such as the US, Europe and Japan have treated these materials as strategic and whilst the Canadian ceramic industry remains small, it does, nevertheless, have the potential to respond to the user requirements in the domestic industrial and manufacturing sectors.

To help coordinate the development and applications of advanced ceramic materials in Canada, the Canadian University-Industry Council on Advanced Ceramics (CUICAC) with the financial assistance of Industry, Science and Technology Canada (ISTC) has prepared this updated Directory which briefly describes the Canadian activities in this field including the academic, manufacturing and user sectors. It is to be hoped that it will promote technical exchange, highlight business opportunities, and assist in attracting investments at the national and international levels. The scope of this Directory, however, has had to be limited in excluding activities in traditional ceramics (sanitary ware, dinnerware).

The information compiled here has been based upon data obtained in response to questionnaires and personal, and/or electronic, communications. Every effort has been made to accurately transcribe the data provided. However, if for any reason data has been omitted, or companies and organisations active in this area not been included, we would be grateful if these discrepancies could be brought to the attention of either ISTC or CUICAC at the following addresses:

ISTC
Advanced Industrial Materials Directorate
235, Queen Street
Ottawa, ON
Canada K1A 0H5

CUICAC
280, Albert Street
Suite 904
Ottawa, ON
Canada K1P 5G8

CUICAC wishes to thank all who assisted us in the preparation of this updated Advanced Ceramics Directory and, in particular, the Materials Branch of ISTC.

EXECUTIVE SUMMARY

Advanced Ceramics are an enabling technology which will have a significant impact on the Canadian industrial sector. These materials will provide the cornerstone for the development of new technologies which will encompass energy efficient and high performance products and processes in a number of sectors including the defence, automotive, resource industries, aerospace, telecommunications, environmental and bio-medical.

Advanced Ceramics include a broad spectrum of non-metallic, inorganic materials produced by new and innovative technologies which have enhanced the properties found in traditional ceramic materials such as dinnerware and sanitary-ware. High wear resistance, high temperature strength, corrosion resistance, dimensional stability and much increased strength-to-weight ratios are a few of these enhanced properties. Advanced ceramic programs include the applications of these materials in high temperature superconductors, in high temperature ceramic filters for efficient clean-up of gaseous exhausts, in filtration of effluents, in high power density batteries, in coatings for gas turbine blades, in fibre-optics and cutting tools just to name a few. Table I shows current and future applications of advanced ceramic materials in a number of areas.

The Canadian advanced ceramics industry comprises a wide range of companies dedicated to the production of functional and structural ceramics as well as the production of fine ceramic powders. It is these microscopically small and extremely pure powders which, when compacted and sintered, produce ceramics with properties not hitherto achievable with other techniques. These same powders when sprayed onto surfaces through plasma guns or lasers can provide ultra-thin and ultra-resistant coatings with innumerable applications. Advanced ceramics are, indeed, the cutting edge into the 21st. century.

It must be borne in mind, at the same time, that the most important resource any country can have is its brain-power. Without a critical mass of ceramic scientists and engineers any future applications of these new materials will be in jeopardy. The academic sector is, therefore, gradually increasing its ceramic-related activities in order to meet the future demands for qualified personnel.

This updated Directory summarises the capabilities and products of the Canadian academic, industrial and public sectors in the field of Advanced Ceramics.

COMPANIES

AASTRA ADVANCED CERAMICS

Description

AASTRA Advanced Ceramics Inc. is a Canadian owned company established in 1964. The company employs 74 people and manufactures piezoceramics. AASTRA currently processes in excess of one ton of ceramic materials each day from a 30,000 square foot facility.

Specialization

AASTRA advanced ceramics manufactures advanced ceramic components of lead - zirconate - titanate (PZT). Several modified forms of PZT compositions are produced under the trademarks AI-4, AI-5, and AI-8. Designed mainly for use in anti-submarine warfare, these products are qualified to meet U.S. and Canadian navy standards.

Additional company activities include high density, high purity alumina crucibles and plates. These are produced for laboratories and PZT production. With the support of the Canadian Department of National Defence, AASTRA is currently pursuing a \$2 million research and development program in the field of large PZT component processing.

International Experience

AASTRA's primary market is the United States. Via prime contractors, AASTRA ceramics have been implemented in most navies of the western world and south east asia. In excess of 95% of plant production is exported.

For Further Information:

President/CEO:

Francis N. Shen

Contact:

Hugh S.B. Scholaert
61 Needham Street
Lindsay, Ontario
Canada K9V 4Z7

PHONE: 705-324-5100
FAX: 705-324-8354

INDUSTRY - MANUFACTURE OF PIEZOCERAMICS

ADVANCED MATERIALS ENGINEERING CENTRE

Description

AMEC was created to assist industry in the development and commercialization of structures, systems and components using advanced materials, and in automated production of advanced materials. A Canadian company established in 1987, they occupy 18,000 square feet of manufacturing space and testing plant.

Specialization

AMEC's involvement in advanced ceramics include services studies and design, prototype manufacturing, testing and analysis, and in technology diffusion.

Services

- ▶ Provide information on business and investment opportunities in Canada's advanced ceramics industry.
- ▶ assist in the discovery, development and marketing of innovative products employing advanced ceramics.
- ▶ assist in the collaboration of industry, university and government research and development advanced ceramics.
- ▶ market ceramics research and development both inside and outside of Canada.
- ▶ provide information and assistance on investment opportunities, R&D tax and financial support programs.

For Further Information:

President/CEO: Lyle Bryson

Contact:

Lucy Kanary
Advanced Materials Engineering Centre
P.O. Box 1618, Station M
Halifax, N. S.
Canada B3J 2Y3

PHONE: 902-425-4500
FAX: 902-422-7907

INDUSTRY - ADVANCED COMPOSITES

ALCAN INTERNATIONAL LIMITED

Description

Alcan International Limited is a complex multinational company. The following is a general description on their parent companies:

Alcan Aluminum Limited

Parent company of Alcan group of companies. Alcan is a Canadian based multinational company involved in all aspects of aluminum production. Products include alumina (and related chemicals), alingot, alloys, semi-fabricated products and some fabricated products. Activities related to ceramics are carried out through various operation entities which form part of the Alcan group.

For Further Information:

President/CEO:

David Morton
Alcan Aluminum Limited
1188 Sherbrooke St. West
Montreal, Quebec
Canada H3A 3G2

Alcan Chemicals

Production and sales of alumina based chemicals worldwide, including reactive aluminas for refractories and fine ceramics, activated alumina, alumina hydrates, aluminum organics, alum, etc. Also production and sales of ZN-SN derivatives for fire retardants. Zirconium chemicals, including partially and fully stabilized zirconias for ceramic applications, ZTA, solgel derived Zirconias for various applications.

For Further Information:

Contact:

Jacques Perry
Alcan Chemicals
1188 Sherbrooke St. West
Montreal, Quebec
Canada H3A 3G2

PHONE: 514-848-8000

FAX: 514-848-1450

C-Axis Technology (Canada) Ltd.

Manufacture and sales of SiC platelets and particulates in several grades. Manufacture and sale of AlN powders for both structural and electronic applications.

For Further Information:

Contact:

Mr. G. Evans
C-AXIS Technology (Canada) Ltd.
1188 Sherbrooke St. West
Montreal, Quebec
Canada H3A 3G2
PHONE: 514-848-8000
FAX: 514-848-8115

Alanx Products L.P.

Limited partnership between Alcan and Lanxide Technologies. Ceramic-Metal composite parts for wear applications, particularly slurry-wear applications for mining, petroleum, chemical manufacturing and similar applications. Production of large and complex shapes to close tolerances using a proprietary manufactured process. Represented in Canada by: Lawjack Inc., Westmount Quebec; Lawjack Inc., Guelph, Ontario; Gulf Protective Coatings, Ltd., Sydney, N.S. and Lynum Engineering Sales, Delta, B.C.

For Further Information:

Teri Mitchell
Alanx Products L.P.
101 Lake Drive
Newark, Delaware
USA 19702
PHONE: 302-454-6934
FAX: 302-453-0194

INDUSTRY - ALUMINUM PRODUCTION & CERAMIC POWDERS

APPLIED MICROELECTRONICS INSTITUTE

Description

Applied Microelectronics was created in 1981 to unite the microelectronics research and development activities at the Technical University of Nova Scotia, the Nova Scotia Research Foundation Corporation and Dalhousie University. It has grown into an independent company engaged in the development of advanced products and in technology transfer.

They employ 30 people and occupy 8,000 square feet of a recently renovated 12,000 square foot facility in downtown Halifax not far from the Technical University of Nova Scotia (TUNS).

Products and Services

AMI's services come under two broad headings: Product Development and Technology Diffusion. Product Development activities are carried out under commercial contract with customers while Technology Diffusion consists of a wide range of more general activities which in many cases are funded by governments.

Product Development

Because of the varied nature of electronic products, our activities are divided into two groups.

1) Electronic Systems

This involves design of new and innovative electronic products intended for manufacture in medium to high volume. Usually this is done in collaboration with the company who will manufacture or sell the product. AMI's contributions involve such activities as conceptual and detailed electronic design, design for manufacturability, cost reduction and manufacturing support.

2) System Integration

Products tend to be large real time software based systems for applications such as sonar, image processing and communications. Often the majority of the hardware is off-the-shelf and product volume is relatively low.

Technology Diffusion

Principal activities include:

- .Providing access to AMI's specialized equipment and facilities.
- .Small consulting studies requiring very specific expertise.
- .Courses and seminars
- .Advice to small companies and, in particular, an Industrial Technology Advisor service sponsored by NRC.
- .Participation in collaborative activities as the Canadian Microelectronics Corporation, Spectrum Technologies and the Burchill Communication Research Group.
- .Helping to link university researchers and industry.

For Further Information:

President/CEO: Dr. Douglas Pincock

Contact:

Debbie LeValliant
Applied Microelectronics Institute
1046 Barrington Street
Halifax, N.S.
Canada B3H 2R1

PHONE: 902-421-1250
FAX: 902-429-9983

INDUSTRY - RESEARCH & DEVELOPMENT FOR COMMERCIAL BUSINESS

APPLIED PHYSICS SPECIALTIES LIMITED

Description

Applied Physics Specialties Limited is a privately held company established in 1964. Applied Physics Specialties has a staff of 21 in a 14,000 square foot facility. Sales are about \$2,000,000 per year.

Specialization

Their main activity is the production of custom optical components for the instrumentation and specialty camera business. A major part of the fabrication of these parts involves the machining of glass and ceramics.

They are currently developing a precision machining centre which has the potential of working ceramics to the very smooth surface finish required for them to meet strength requirements.

International Experience

20 percent of their production is exported.

For Further Information:

Contact:

President/ CEO:

Martin High
Applied Physics Specialties Limited
17 Prince Andrew Place
Don Mills, Ontario
Canada M3C 2H2

PHONE: 416-445-1870

FAX: 416-445-7977

**INDUSTRY - MANUFACTURER OF OPTICAL COMPONENTS AND ASSEMBLIES,
MACHINING GLASS**

B. M. HI-TECH INC.

Description

B.M. Hi-Tech is a wholly-owned subsidiary of Sensor Technology Limited. Since incorporation in 1983, the company has grown steadily and offers a comprehensive range of piezoelectric ceramics and components. The company's manufacturing and R&D activities occupy a 2800 square-foot facility in Collingwood, Ontario and employs 20 people.

Specialization

B.M. Hi-Tech Inc. produces a full range of advanced materials and systems that include ceramics, glasses, composites, sensors and instrumentation. The products currently marketed by the company include the following.

- ▷ Piezoelectric Ceramics: Modified compositions of lead zirconate titanate (PZT), Leadmetaniobate (PMN) and Lead Titanate.
- ▷ IR Glasses, Glass Ceramics and Laser Materials: Heavy Metal Fluoride Glasses based on ZBLAN and ZBGAN.
- ▷ Sensors & Devices: monolithic, multilayer and composites.
- ▷ Process Instrumentation: custom designed systems and high temperature process instrumentation.
- ▷ Custom fabrication, pressure sintering, silver, gold and nickel metallization.
- ▷ MIL-STD compliance and certification.

International Experience

The company currently exports its products to the U.S. and to the European Community (EC).

For Further Information:

President/CEO:

Dr. S. E. Prasad
B.M. Hi-Tech Inc.
P.O. Box 97
12 Stewart Street
Collingwood, Ontario
Canada L9Y 3Z4

PHONE: 705-444-1440
FAX: 705-444-6787

INDUSTRY - TECHNICAL CERAMICS, SENSORS & SYSTEMS

CANCARB LIMITED

Description

Cancarb Limited, a wholly-owned subsidiary of Trans Canada Pipe Lines Limited, is the world's largest manufacturer of high-quality carbon black sold under the trade name 'Thermax'. With its head office in Medicine Hat, Alberta, it produces 60 million pounds of carbon black products each year and employs 55 people.

Cancarb has acquired process technology for the synthesis of high-quality beta silicon carbide powders. The powders, which may be commercially available soon, are expected to be most suitable for the manufacture of advanced structural ceramics, electronic components and metal-ceramic and ceramic-ceramic composites.

Specialization

At present, Cancarb Limited specializes in the manufacture and sale of high-quality thermal carbon black and will soon be manufacturing high-quality beta silicon carbide powders as well.

Products

The present carbon black products are:

- Thermax Floform N-990
- Thermax Powder N-991
- Stainless Thermax Floform N-907
- Stainless Thermax Powder N-908
- Thermax Floform N-990 Ultra-Pure
- Thermax Powder N-991 Ultra-Pure.

International Experience

Cancarb has a well established international network of agents through which its carbon black products are sold in 17 countries. The company plans to market its beta silicon carbide powders in the international market.

For Further Information:

Contact:

Mr. R. D. Wale
President & Chief Operating Officer
Cancarb Limited
P.O. Box 1000, Station M
Calgary, Alberta
Canada T2P 4R5

PHONE: 403-267-2656
FAX: 403-267-2654

INDUSTRY - MANUFACTURE OF HIGH-QUALITY THERMAL CARBON/
BETA SILICON CARBIDE POWDERS

C-AXIS TECHNOLOGY

Description

C-Axis Technology was formed as a wholly owned subsidiary of Alcan Aluminium Limited to exploit newly developed, proprietary technologies to manufacture carbides, nitrides and borides. The company was founded in September of 1988 and now employs 14 people. Located in the Saguenay region of Quebec, in the heart of Alcan's smelter and chemical complex, the plant is approximately 300 miles northeast of Montreal. Their main activity is to provide Fine Ceramic Powders for markets in the USA, Japan and Germany.

Specialization

C-AXIS is dedicated to supplying the growing demand for ceramic reinforcing materials worldwide. They are committed to supplying high performance materials which are both environmentally safe and of consistent high quality and purity.

Growing markets for materials such as carbides, nitrides and borides as reinforcements include ceramic matrix composites (CMC), metal matrix composites (MMC), and polymer composites. Potential applications include cutting tools, wear parts, heat exchangers, crucibles, armor and engine components.

Advanced Ceramics Activities

- ▶ Ceramic powders produced by C-AXIS are ideal reinforcements for metals making them stronger and stiffer and more wear resistant. Platelets offer further improvements due to their high aspect ratio.
- ▶ When employed in ceramics and intermetallics, C-AXIS platelets improve their strength, toughness and high temperature creep resistance. Furthermore, due to their planar nature,

platelets can undergo preferential alignment giving unique surfaces for wear applications.

- ▶ C-AXIS sets the tone for product quality and new product development with state of the art equipment for product characterization and process controls. Batch furnaces are utilized for product development. Stringent quality control is guaranteed. Platelet shape and size is constantly monitored using SEM-techniques. Nitrogen/Oxygen Analyzers are used.

Products currently offered include:

- .SiC Particulate for MMC Applications;
- .SiC High Aspect Ratio Platelets (H.A.R.);
- .ALN (Structural Grade)

Products under development include other carbides and borides and surface treatments and coatings to enhance matrix compatibility in final composites.

- Alpine Jet Milling & Classifier
- High Temperature, high through-put furnace (2500 degrees)

International Experience

Markets its products internationally and has a sales office located in Scottsdale, Arizona.

For Further Information:

Contact:

Jean-Luc Bernier
Director of Operations
C-AXIS Technologies Canada Ltd.
2538, Dubose, C.P. 1385
Jonquiere, Quebec Canada G7S 4K9
PHONE: 418-699-3951
FAX: 418-699-3946

INDUSTRY -- SILICON CARBIDE PLATELET, ALUMINUM POWDERS AND OTHER ADVANCE CERAMIC MATERIALS

CERAMICS KINGSTON INC.

Description

Ceramics Kingston Inc., is a dynamic high-tech corporation, privately owned with a broad shareholder base. Its location in Kingston, Ontario, is ideal from which to serve the many industries in the industrial south-eastern corridor of the province as well as "Silicon Valley North" in Ottawa, Ontario.

The company conducts its business through five divisions: Structural Ceramics; Electronic Ceramics; Bio-Ceramics; Space Technology; and Marketing and Technology Brokerage.

The company is a member of the Canadian Advanced Industrial Materials Forum and is especially interested in international and national projects for mutual advantage with other companies.

Specialization

Ceramics Kingston Inc. specializes in:

- ▶ development, manufacture and marketing of advanced ceramic materials and products for both electronic and structural applications;
- ▶ marketing analysis for use of advanced materials in the North American and international markets;
- ▶ technology brokerage worldwide with services ranging from conceptual design to turn-key operations.

Products

The company products include:

- ▶ nitrides
- ▶ carbides
- ▶ borides
- ▶ composites.

International Experience

The personnel of Ceramics Kingston Inc. have experience on projects in Africa, Asia, South America and the U.S., through private corporations as well as through the federal Canadian International Development Agency (CIDA), Ottawa, and the International Development Research Council (IDRC), Ottawa.

For Further Information:

Dr. Raman R. Sood
The President's Office
Ceramics Kingston Inc.
P.O. Box 655
Kingston, Ontario
Canada K7L 4X1

PHONE: 613-548-7253

INDUSTRY - DEVELOPMENT, MANUFACTURE & MARKETING OF ADVANCED CERAMIC MATERIALS

CLAYBURN REFRACTORIES LIMITED

Description

Clayburn Refractories Limited is a wholly owned subsidiary established in 1907 and employs 120 people. Parent company is I.XL Industries Limited located in Medicine Hat, Alberta.

Specialization

Clayburn are manufacturers of high alumina refractory products in brick, castable and plastic form. These refractories can be classified as a low to medium technology.

They have developed a new method of lining melting pots using a powdered refractory rather than the traditional brick. Their main market areas are lime and cement kilns, petrochemical industries, incinerators, industrial boilers and heat treatment furnances.

Clayburn also manufactures a unique insulating refractory brick using diatomaceous earth. There are only two manufacturers of this product in the world (the other is in Denmark). Main application is the aluminum smelting industry.

International Experience

Clayburn main export market is the Aluminum Industry world wide where it sells products for lining electrolysis pots.

For Further Information:

Contact:

President/CEO:

John A. Ekels
Clayburn Refractories Limited
33765 Pine Street
Abbotsford, B.C.
Canada V2S 5C1

PHONE: 604-859-5288
FAX: 604-859-0424

INDUSTRY - MANUFACTURE OF HIGH ALUMINA REFRACTORY PRODUCTS AND
FACE BRICK

COM DEV LIMITED

Description

COM DEV Limited was founded in 1971 and for the past 15 years has supplied its technology into every Canadian Space program. More than 100 satellites either in operation or under construction use COM DEV equipment. As the premier supplier of multiplexing and switching equipment for Communications Satellites the company supplies over 65% of the Western World's requirements. The company employs 390 people and major markets are in the USA and Europe.

Specialization

- ▶ COM DEV is part of an international team which was recently selected to supply the third generation of Maritime Satellites, known as INMARSAT III. These satellites provide global communication for shipping and will be the first to use on-board processing. This equipment, to be supplied by COM DEV, will enable the satellites to become "switchboards in the sky".
- ▶ Remote sensing and space science satellites which play a crucial role in the monitoring of the earth's ecology also use COM DEV's subsystems.
- ▶ COM DEV is also working with the National Research Council and the University of Toronto on the design of a monitoring system which will continuously measure the status of the Greenhouse Effect in the upper atmosphere. As SPAR's major Canadian subcontractor on Radarsat, COM DEV will develop and supply a substantial portion of the satellites radar payload.
- ▶ Over the past five years COM DEV has broadened its technology and product base, building a capability in defence related spaceborne, airborne,

shipborne and ground based electronics subsystems. Current programs include jam-resistant, encrypted space based equipment and airborne electronic surveillance systems capable of detecting, locating and identifying electromagnetic emitters over an extremely wide frequency spectrum.

Unique Equipment/Machinery in Plant

- Environmental Lab for Space
- Equipment to manufacture GaAs devices
- Electrical Discharge Machinery for precision millimeter/microwave Equipment.

International Experience

COM DEV is now part of an international team and has maintained a position as a world technology leader in each of its business areas. In 1985 COM DEV established a subsidiary in England where strong business growth has resulted in the company outgrowing its facility. By 1992 when the "Single European Act" becomes fully effective, COM DEV Europe will have a complete capability to design and manufacture advanced equipment for European space and defence markets.

For Further Information:

President: Keith Ainsworth

Contact:

Dr. Chandra Kudsia
COM DEV Limited
155 Sheldon Drive
Cambridge, Ontario
Canada N1R 7H6

PHONE: 519-622-2300

FAX: 519-622-1691

INDUSTRY - ADVANCED CERAMICS MATERIALS USER

CRYSTAR RESEARCH INC.

Description

Crystar Research Inc. of Victoria, B.C. is a subsidiary of Johnson-Matthey. Established in 1987, with a technical staff of five, this company brings 25 years of electronic materials experience to the field of advanced optical ceramics. In 1991 their staff will increase to 15.

Facilities include two oxide Czochralski crystal pullers and advanced polishing and characterization equipment. Presently, sapphire crystals up to 5 inches in diameter and 14 kg in weight can be grown.

Crystar projects include research on titanium sapphire, rubies and garnets such as YAG*, YIG* and GGG*; research on the development of flux growth technology; and investigation of future production of potassium titanyl phosphate (KTP), beta-barium borate (BBO) and lithium triborate (LBO) crystals.

Sapphire crystal products are used to make lenses for infra-red applications; polished wafers are used as hosts for micro-electronic circuits and infra-red detectors. YAG titanium sapphire and ruby crystals are used for solid-state laser applications. KTP, BBO and lithium triborate crystals will be used for light signal processing technology. These "non-linear" crystals can change the wave length of existing lasers to provide new applications.

Specialization

Crystar Research Inc. specializes in:

- ▶ opto-electronic materials research;
- ▶ oxide crystal growth;
- ▶ optical and mechanical characterization of oxide crystals;
- ▶ fabrication of customized shapes.

Products

Present products are:

- ▶ ultra-pure and doped sapphire (including ruby) crystals in all popular orientations up to 5 inches diameter;
- ▶ precision custom-fabricated lenses, bars, rods and wafers.

International Experience

Crystar Research Inc. has research and development contracts with European aerospace companies and the United States Airforce. Its products are custom made and are destined for international markets.

- * YAG = yttrium aluminum garnet
- YIG = yttrium iron garnet
- GGG = gadolinium gallium garnet

For Further Information:

Contact:

Mr. Robert F. Redden
President
Crystar Research Inc.
721 Vanalman Avenue
Victoria, B.C.
Canada V8Z 3B6

PHONE: 604-479-9922
FAX: 604-479-2734

INDUSTRY - OPTICAL MATERIALS

DATCO TECHNOLOGY LIMITED

Description

Datco Technology Limited is a wholly Canadian-owned company located in Burlington, Ontario. Incorporated in 1987, the company is affiliated with J.O. Bernt and Associates Ltd., a Canadian firm specializing in the design, manufacture and installation of high-temperature industrial heat exchange systems. It shares the latter's manufacturing facility, comprising about 10,000 square feet of space. The present staff consists of two engineers and a full production staff.

Specialization

Datco Technology specializes in the development and manufacture of advanced ceramic coatings for high-temperature protection and fire-resistant applications.

Products and Services

- ▶ The company provides technical consulting and research and development services in the field of high-temperature inorganic binders and coatings.
- ▶ Specializes in the development and manufacturing of advanced ceramic coatings and systems for fire protection applications.

International Experience

Through its affiliate, J. O. Bernt and Associates Ltd., Datco Technology has linkages with several key industries in North America, specifically in the cement, lime, mining and pulp and paper sectors.

Datco Technology's staff has extensive experience in international markets especially the U.S., South America and Australia, all of which are targetted to provide the commercial volumes for the sale of Datco's fire-protective coatings.

For Further Information:

President/CEO: Dave Nguyen

Contact:

J. O. Bernt
DATCO Technology Limited
3375 Laird Road, #3
Mississauga, Ontario
Canada L5L5R7

PHONE: 416-569-7392
FAX: 416-569-7696

**INDUSTRY - MANUFACTURER OF ADVANCED CERAMIC COATINGS FOR
HIGH-T PRODUCTION**

EDO CANADA LIMITED

Description

EDO Canada Limited was founded in 1979 as a wholly owned subsidiary of EDO Corporation of New York, N.Y., USA. EDO Canada Limited (ECL) is an example of the new breed of Alberta pioneer. Equipped with technological foresight, an enthusiastic team of professionals, and an aggressive "can do" attitude, ECL has captured a number of lucrative contracts and established itself as a significant competitor in the international defence and aerospace industries.

In 10 years the company has risen from 30 to approximately 100 employees and in less than 3 years expects to reach 250. In 1989 they relocated to a new 65,000 square foot facility. This facility houses the manufacturing, engineering, and administrative services of all ECL operations.

Specialization

In the 1980's ECL's commitment to success, through expansion and diversification, resulted in the achievement of three major milestones:

- ▶ the broadening of its electronic navigation and satellite positioning market base;
- ▶ the creation of engineering and manufacturing capabilities for filament wound and hand lay-up composite structures;
- ▶ and the establishment of a pilot plant for the research and development of advanced structural ceramics.

Advanced CeramicS Activities

The structural ceramics research and development plant continues to test and market the feasibility of producing net-shape complex

geometric shapes using a high pressure injection moulding process. Initial testing and evaluations are being carried out using materials such as alumina, toughened zirconia and silicon carbide.

Complex-shaped structural ceramics at cost competitive prices is the latest capability offered by EDO after 30 years in business. EDO Canada Limited has capitalized on the most recent advances in ceramic technology by combining submicron ceramic powders with the unique production technology of high pressure injection moulding (HPIM).

International Experience

EDO Corporation has 30 years in the ceramics business and is the leading supplier of piezoelectric ceramics in the Western world. With operations in California, Utah and the United Kingdom, EDO has now expanded its ceramics technology to Canada.

For Further Information:

President/CEO: J.S. Butyniec

Contact:

Jim Foster
EDO Canada Limited
1940 Centre Avenue N.E.
Calgary, Alberta
Canada T2E 0A7

PHONE: 403-569-5400
FAX: 403-569-5499

INDUSTRY - STRUCTURAL CERAMICS - HPIM

ELECTROFUEL MANUFACTURING COMPANY LIMITED

Description

The Electrofuel Manufacturing Company Limited was founded in 1983 to develop and manufacture LiAl-FeS batteries. The experience gained in the development of boron nitride separators, as well as the market potential for advanced ceramics, acted as catalysts in expanding the scope of the company to become a manufacturer and supplier of advanced ceramic materials and high-technology specialized products.

The company, located in Toronto, has over 10,000 square feet of research and development space and 20 R&D personnel. It also has extensive manufacturing facilities. In addition to standard advanced ceramic processing equipment facilities, Electrofuel has a custom-designed high-temperature (2200 C), high-pressure (50,000 psi) hot press with capabilities to form components with diameters of up to 12 inches.

Specialization

The Electrofuel Manufacturing Company specializes in:

- ▷ development and manufacture of advanced structural ceramics based on boron nitride, titanium diboride, silicon carbide and toughened alumina;
- ▷ energy storage systems, particularly LiAlFeS batteries;
- ▷ electrochemical devices;
- ▷ design and construction of high-temperature furnaces (high-pressure hot press); controlled atmosphere high-

pressure capability;
microgravity space capability;

- ▷ specialized engineering.

Products

Electrofuel manufactures a diverse range of products:

- ▷ monolithic boron nitride (BN) ceramics used as break rings in continuous casting of steel, kiln furniture, insulators, heat sinks and crucibles for melting glasses and metals;
- ▷ boron nitride fibres for battery separators, high-temperature gaskets and rotary seals, high temperature insulation and composites;
- ▷ alumina-SiC whisker composites for cutting tools, extrusion dies, valve and pump components;
- ▷ titanium diboride-based evaporating boats for aluminizing plastics and paper products;
- ▷ toughened alumina for cutting tools and parts for wear-resistant applications;
- ▷ wear-resistant parts made of Si_3N_4 , SiC, TiB_2 , etc.;
- ▷ specialty furnaces Hot Press Sinter, Hot Isostatic Pressing (HIP) and dilatometer for HIP.

International Experience

Contact:

Dr. S. Das Gupta, President
Electrofuel Manufacturing Company Limited
9 Hanna Avenue
Toronto, Ontario
Canada M6K 1W8

PHONE: 416-535-1114
FAX: 416-535-2361

INDUSTRY - DEVELOPMENT & MANUFACTURE OF ADVANCED STRUCTURAL CERAMICS & HIGH TEMPERATURE HOT PRESSES

HAMILTON PORCELAINS LIMITED

Description

Hamilton Porcelains Limited was a privately-owned Canadian company which began operations in 1852. The company was acquired by Saint-Gobain in November 1989, and is now part of an extremely large International organization. It originally produced artware and household ceramic products in Hamilton, Ontario. The company moved to Brantford, Ontario, and diversified its product line to include industrial products. Over the years, Hamilton Porcelains de-emphasized its artware and household ceramic product lines to become a technology-oriented company. It now employs 110 people.

At present, the company operates two manufacturing facilities. The plant in Brantford continues to produce existing product lines to meet the requirements of longstanding customers. A new facility commissioned in Paris, Ontario in 1987, incorporates state-of-the-art, fully-automated, microprocessor-controlled equipment for the manufacture of specialty products developed in-house in the company's R&D laboratory.

Specialization

Hamilton Porcelains specializes in custom design and production of a wide variety of complex and unique technical and industrial ceramic shapes. Its highly specialized tool and die department is capable of designing and fabricating dies for compression moulding of ceramics.

Products

More than 1000 geometric shapes are presently produced from both customer owned and Hamilton Porcelains tooling. A wide variety of generic ceramic materials are used to fabricate a multitude of components listed below:

- ▷ triaxial electrical porcelain (low to medium voltage);
- ▷ zircon materials for high strength refractory shapes (e.g., high voltage arc-chute and switch gear components);
- ▷ cordierite perforated honeycomb ceramic tiles for infrared radiant heating equipment;
- ▷ semi-cordierites for highly specialized thermal shock-resistant applications;
- ▷ mullite-pyrophyllite hybrid refractory shapes for filtration of metal used in automotive components.

International Experience

The company has established an international market for its products. Seventy-five percent of its production is exported to the U.S., South America, Mexico, Puerto Rico, Japan, Italy, Germany, Belgium, Spain, Sweden, Korea, Ireland and India.

For Further Information:

Mr. R. G. Robb, President & CEO
Mr. A. L. Matthews, Director Engineering R&D
Mr. D. Stevenson, Technical Sales

Hamilton Porcelains Limited
25 Campbell Street
P.O. Box 594
Brantford, Ontario
Canada N3T 5N9

PHONE: 519-753-8454
FAX: 519-753-5014

INDUSTRY - DESIGN & PRODUCTION OF CERAMIC SHAPES

ICS INC.

Description

ICS Inc. is a Calgary, Canada based company specializing in custom designed and manufactured high performance ceramic wear products for industrial applications. These ceramic lining systems are designed to address hostile environments characterized by extreme abrasion, extreme corrosion and high temperature and thermal shock.

Specialization

Services:

- ▶ complete applications consulting
- ▶ complete CAD design, pattern and mould making
- ▶ high temperature sintering
- ▶ pre sintering and post sintering finishing
- ▶ the production of large monolithic custom shapes and lining systems
- ▶ the production of one-of-a-kind special shapes and large runs.

Materials:

- ▶ silicon carbide composite
- ▶ high alumina
- ▶ The casting method of forming ceramics has been selected to:
 - ▶ minimize tooling costs
 - ▶ allow economical production of large, complex monolithic shapes
 - ▶ make smaller runs more economical
 - ▶ provide flexibility to produce a variety of complex shapes.

Quality and Testing:

- ▶ materials are constantly tested for consistency
- ▶ raw materials milled to rigid specifications, are tested for particle size and distribution, then adjusted and fine tuned to meet elected desirable

properties.

- ▶ composition batches are tested to ensure that each has the properties required for the intended application.
- ▶ finished pieces are tested for physical and mechanical properties.

Research & Development:

- ▶ ICS is constantly monitoring its products already in use to determine the need for future improvements.
- ▶ research and development ensures that technologies of the future are available.

Industries Served:

- ▶ coal mining and preparation
- ▶ mineral mining and processing
- ▶ steel
- ▶ tar sands
- ▶ oil and gas
- ▶ coal-fired power generating plants
- ▶ pulp and paper
- ▶ potash
- ▶ grain handling
- ▶ cement
- ▶ sand and gravel

For Further Information:

President:

J. B. Kalbfleisch
Industrial Ceramics Systems, Inc.
Bay C, 7004-5th Street S.E.
Calgary, Alberta
T2H 2G3

PHONE: 403-253-2793
FAX: 403-255-2346

INDUSTRY - CUSTOM MANUFACTURING OF HIGH PERFORMANCE CERAMICS

INCO LIMITED

Description

Inco Limited is a Canadian company that conducts business worldwide. It is the world's leading producer of nickel, copper, cobalt and precious metals. It is also the world's largest supplier of wrought and mechanically alloyed nickel alloys as well as a leading manufacturer of blades, discs, rings and other forged and precision-machined components made from special alloy materials used in gas turbine engines. In 1990, it employed 19,387 people. The net sales for 1990 were about US\$ 3.11 billion.

In primary metals, the company operates six divisions: two in Canada, and one each in Indonesia, Wales, England and New Caledonia. Alloys and engineered products operations are carried out through Inco Alloys International, with the principal operating units located in the U.S. and the U.K.

The extractive metallurgy research Laboratory of Inco, J. Roy Gordon Research Laboratory, is in Sheridan Park, Ontario. While its work is mainly in extractive research for its operating divisions, it also carries out research with the alloy division on the development and use of advanced ceramic coatings involving Physical Vapour Deposition (PVD) and plasma-coating techniques. Five to ten person-years are used in this area.

Specialization

Besides its activities as the largest producer of metals and alloys, Inco is active in the development of advanced ceramic coatings on its alloy material components to improve their high-temperature properties and performance.

Products

Inco's advanced ceramics products are still in the development stage. Primarily, these will be alloy components manufactured by Inco Alloy and Engineered Products divisions with protective ceramic coatings for high temperature and special environment applications.

International Experience

Inco Limited has operations in 19 countries throughout the world. Its alloy and engineered products activities are carried out in Canada, U.S., Europe, Japan, Australia, Taiwan and Hong Kong. Its products are sold throughout the world.

For Further Information:

Contact:

Dr. J. A. E. Bell
Director
J. Roy Gordon Research Laboratory
Inco Limited
Sheridan Park, Ontario
Canada L5K 1Z9

PHONE: 416-822-3322
FAX: 416-822-3922
TELEX: 06-982263

INDUSTRY - ADVANCED CERAMIC COATINGS

JACOAT COMPANY

Description

JaCoat Company was established in 1976, initially to provide wear-resistant coatings for textile machinery components used in the manufacture of synthetic fibre, and subsequently for other industrial uses. It is a division of George A. Wright & Son, established in 1896 to provide metal machining services to industry, and which now employs 40 people. Its facilities include two Metco plasma high and low-velocity units (rating of 40 kW and 80 kW) and metal machining and preparation equipment. The company now has a staff of eight.

Specialization

JaCoat Company specializes in providing plasma and flame-coating services to industry. The coatings, including oxides, carbides and metals, are custom designed to provide wear and abrasion resistance to parts and components used by industry.

In order to meet severe operating conditions, JaCoat has developed specialized technology to control the quality and thickness of the plasma and flame coatings.

Services

Coating services are provided to the pulp and paper, cable and pump manufacturing and gas turbine industries. In addition to high and low-velocity plasma and flame coatings, JaCoat provides full machining and fabricating services.

International Experience

JaCoat has provided development services to companies in the U. S., Japan and South Africa as well as to member companies of the British Surface Engineering Society.

For Further Information:

Contact:

Mr. D. C. Radford
Manager
JaCoat Company
146 Hickson Avenue
P.O. Box 63
Kingston, Ontario
Canada K7L 4V6

PHONE: 613-548-3128

FAX: 613-542-1345

INDUSTRY - PLASMA AND FLAME-COATING SERVICES

JAY-EM CERAMICS

Description

Jay-Em Ceramics is a division of Jay-Em Inc., a private Canadian holding company. Founded in 1986 to provide custom-designed advanced ceramic coatings, its facilities include a 80 kW Metco Plasma unit with supporting equipment. At present, production and laboratory facilities occupy about 1000 square feet.

With a total staff of four, Jay-Em Ceramics holds a unique position amongst plasma-coating companies in Canada because of its combined research and development and service production capabilities.

Specialization

Using plasma-coating technology, Jay-Em Ceramics specializes in the development and application of advanced ceramic coating to resist wear, abrasion and corrosion.

The company provides standard state-of-the-art coatings for routine applications, but its unique strength is its scientific and technical capability in providing custom-designed plasma coatings. In many instances, the company acts as the R&D arm of its client to develop and apply optimum plasma coatings to satisfy specific needs.

Services

The scope of services includes:

Routine plasma coatings:

- compositions based on oxides, carbides, cermets, metal alloys and plastics;

- applications such as wear resistance, corrosion resistance, thermal barriers, dielectric protection, worn area rebuilding, etc.;

Services are provided to aerospace automotive, electrical and electronics, and paper, marine, petrochemical, mining, machine tool and machinery industrial sectors.

Advanced coatings development:

- provides services in the development and application of custom coatings;
- develops coating processes for novel applications;
- provides R&D support to client companies in the design, development and manufacture of advanced ceramic-coated components and parts.

Products

At present, Jay-Em Ceramics does not manufacture any products for commercial sale. However, it has an in-house R&D program to develop components based superconducting advanced ceramic films.

For Further Information:

Mr. Suktek Johar
General Manager
Jay-Em Ceramics
8 Melanie Drive, #8
Brampton, Ontario
Canada L6T 4L2

PHONE: 416-458-8638
416-451-3200

INDUSTRY - PLASMA COATING SERVICES

KENNAMETAL LIMITED

Description

Kennametal Limited is a subsidiary of the U.S. owned Kennametal Inc., the world's largest producer of hard carbide alloys. The U.S. corporate head office is in Latrobe, PA; the Canadian head office is in Toronto, Ontario, with manufacturing facilities in Toronto and Langford, B.C. The sales office and/or distributors are located all across Canada.

Kennametal Limited employs 230 people. These include five in Research & Development and engineering, and 110 production workers (30 in Toronto and 80 in Langford).

Specialization

Kennametal Limited specializes in the development, manufacture and application of cemented carbide and other ceramic materials. These are used to machine, cut, shape and form ferrous and non ferrous alloys, pure metals, wood, plastics, coal, asphalt, concrete and other solid materials.

Products and Services

Kennametal Limited markets all the products and services available through its parent company, Kennametal Inc., an established leading manufacturer of metal-cutting and metal-forming products, and other abrasion, wear and corrosion resistant products. These include the following cutting-tool materials: silicon nitride (sialon) ceramics; alumina-based whisker reinforced ceramic; alumina/TiC ceramic; alumina ceramic; cermet (TiC/TiN); polycrystalline diamond; cubic boron nitride (CBN).

In Canada, Kennametal Limited manufactures tungsten carbide and diamond-based products, both coated and uncoated. These include cutting-tool inserts; stationary and rotating tool

holders; workholding devices; collets and chucks; drills; boring bars; mill cutters; and numerous accessories.

- ▷ The company also markets electronic devices for controlling the critical link between the machine tool and the work piece;
- ▷ For demanding wear and specialty applications, Kennametal supplies other products engineered to take advantage of such characteristics of tungsten carbide as high hardness and density, compressive strength and exceptional resistance to wear, corrosion and pressure;
- ▷ Kennametal pioneered the introduction and application of tungsten carbide undercutter bits and drill bits for mining coal in the U.S., then applied these tools to the mining of potash and trona. It has also developed tungsten carbide tools for road construction and repair and the maintenance of streets and highways.

Most of the hard carbide powders used by Kennametal are supplied by its sister company, Macro Division of Kennametal Inc., in Port Coquitlam, B.C.

International Experience

Kennametal Limited's international exposure is through the vast network of Kennametal Inc., whose manufacturing plants and consolidated subsidiaries are located in about 30 countries.

For Further Information:

M. D. Green
Kennametal Limited
1425 The Queensway
Toronto, Ontario
Canada M8Z 1T4
PHONE: 416-252-7851
FAX: 416-252-4034

INDUSTRY - PRODUCERS OF CARBIDE CUTTING TOOLS

KENNAMETAL INC., MACRO DIVISION

Description

Macro is a division of Kennametal Inc., of Latrobe PA. Established in 1938 in Latrobe PA, Mr. Philip McKenna began the Canadian Division in Port Coquitlam, B.C., in 1952. It now employs about 70 people including production workers and research and development staff.

Its strong R&D capabilities have led to the development of new materials and to the assistance for end-users in the development of improved products. The company has a good reputation for product quality in both domestic and export markets.

Specialization

Macro Division specializes in the manufacture of advanced ceramic powders (hard metal carbides) using the proprietary Menstruum process technology. In addition, the company specializes in the formulation of fully processed hard metal carbide blends ready for processing into products by its customers.

Products

Macro Division markets four broad varieties of product:

- ▷ intermediate carbides and nitrides such as WC, TiC, WC/TiC, TiN, and TaC/NbC;
- ▷ fully prepared hard metal carbide powder blends such as those resulting from the mixing of various carbides and auxiliary minor alloys such as cobalt;
- ▷ diamond tool matrix powders such as W and WC to make diamond-set and impregnated tools;

- ▷ hard-facing products such as gas and electric hard-facing welding composite rod and pads, flame and plasma-spray powders as well as bulk tungsten carbide powders.

International Experience:

The company markets its products in 35 countries throughout the world, both to other Kennametal divisions and to outside customers. Macro Division is an important supplier of metal carbide and nitride powders to Japan where it has had an established market for over 25 years. The products are sold there through its agents, New Metals & Chemicals Corporation Ltd., Shin Dai-Ichi Building, #4-13 Sanchome, Nihonbashi, Chuo-Ku, Tokyo.

For Further Information:

Contact:

A. C. Rinella
Assistant Process Development Engineer
Kennametal Inc., Macro Division
1651 Kingsway Avenue
Port Coquitlam, B.C.
Canada V3C 1S3

PHONE: 403-941-9611
FAX: 403-941-3525
TELEX: 04-353516
CABLE: MICRON, PORT COQUITLAM

INDUSTRY - CARBIDE AND CERAMIC CUTTING TOOLS & WEAR PARTS

LAKE SIDE ELECTRONICS LIMITED

Description

Lakeside Electronics Limited is a wholly Canadian-owned company, founded in 1969 to produce custom-made electronic ceramics. Within a few years the company has become one of the main Canadian producers of piezoelectric transducers for special applications. A significant part of the company's activities involves research and development in the field of ceramics and conductive coatings.

The manufacturing and laboratory facilities occupy about 8000 square feet of space. The number of staff is six.

Specialization

Lakeside Electronics Limited specializes in the manufacture of lead zirconate titanate (PZT) piezoelectric ceramics and a variety of conductive inks and pastes which could be used on different types of substrates.

Products

Products manufactured and sold are:

- ▶ PZT piezoelectric ceramics made to customer specifications for use in depth-sounding sonar, fish finders and other ultrasound devices;
- ▶ conductive inks and pastes for a variety of ceramic, glass and plastic substrates.

International Experience

Lakeside products are used by customers both in Canada and the United States.

For Further Information:

Contact:

Mr. Al J. Ankus, PEng.
President
Lakeside Electronics Limited
321 Hopkins Street
Whitby, Ontario
Canada L1N 2C1

PHONE: 416-668-2981

INDUSTRY - CUSTOM-MADE ELECTRONIC CERAMICS

THE LASER INSTITUTE

Description

The Laser Institute was founded in 1984 and employs 17 people. The primary objective of The Laser Institute is to contribute to economic expansion and diversification by strategically incubating and introducing laser technology. The Institute, conceived by the University of Alberta in 1984, encourages and assists industry in the use of lasers.

Pioneering research in laser technology began at the University of Alberta soon after the development of the first laser in 1961. During the ensuing years, the research activities were broadened and strengthened and have long since gained worldwide recognition and respect. They serve as the vehicle to transfer this knowledge to industry.

Specialization

While an interdisciplinary approach is applied toward projects, the professionals at The Laser Institute specialize in four areas of laser applications:

- 1) Material Processing
- 2) Optoelectronics
- 3) Metrology
- 4) Automation

Services

Initial attention has been focused on applications in laser materials processing, optoelectronics and laser based metrology - a focus appropriate to indigenous industry.

- Clients can select from a wide spectrum of services in all levels of applied research, development and engineering. Services include process and procedure development, design, prototype development, testing, feasibility studies

and business planning.

- The Laser Institute Jobshop, unique in Alberta, affords an excellent opportunity for clients to assess the merits of laser processing. Manufacturers, who may not be able to economically justify the purchase of their own in-house lasers, are able to obtain the unique advantages of using lasers. Custom laser-based precision measurement is available, for businesses requiring accurate, economical information.
- Through the presentation of seminars and courses, they provide education and training in laser technology in general and communicate results of the core program.
- Provides such services to company and individual clients in diverse industries, including oil and gas, agriculture, transportation, manufacturing, electronics, medicine and food processing.

International Experience

Through their applied research and development program, they keep abreast of new developments worldwide and maintain a leading edge position.

For Further Information:

President/CEO:

Dr. Don C.D. McKen

The Laser Institute

9924-45 Avenue

Edmonton, Alberta

Canada T6E 5J1

PHONE: 403-436-9750

FAX: 403-437-1240

INDUSTRY - RESEARCH & DEVELOPMENT IN APPLICATIONS OF LASERS

METAL 7 INC.

Description

Founded in 1975, Metal 7 Inc. is a Canadian company with its head office and plant in Sept-Iles, Quebec. It started as a machine and metal working shop to serve the resource industries of Quebec but since the late 1970s, it has been manufacturing high-technology, high-performance industrial parts and components using thermal-spray and plasma-coating equipment. The company employs 45 people: 35 production staff and 10 engineering staff. The sales of ceramic-coated components have increased from 5% of sales in 1981 to about 75% in 1990 and are increasing as scheduled.

Specialization

Metal 7 Inc. specializes in the development and application of thermal-spray coatings to yield highly wear-resistant process machinery parts, primarily for use in resource industries such as iron ore pelletizing, pulp and paper and aluminum processing.

The company's expertise lies in using thermal-spray coating technology to apply thin but highly durable ceramic, metallic and cermet coatings on components and parts subject to heavy wear, or as a thermal shield.

Products

The company manufactures original parts and components. It also provides refinishing services. Almost 80% of its sales of coated products are concentrated in the iron ore industry. Screen deck roll, in particular, is the only product for which the company has developed a volume application. All other applications are essentially low-volume specialized parts and components, even in the pulp and paper industry which is the company's second largest market.

Recent new product applications include:

- ▶ casting gates. Vibrating rods, liners for burners and valve bottoms for mineral separation - all for iron ore pellet plants;
- ▶ mixing "fingers" and exterior structures for the pulp and paper industry;
- ▶ ball valves for the oil and chemical industries;

The company has added extensive laboratory facilities such as a scanning microscope - traction machine etc. and is halfway through a research program of which a large part is centered around ships diesel engines. The other main area concern the development of different thermal shielding.

Combustion

As a complement to the laboratory, the company has built an experimental combustion tunnel of 5 MW and in the process is marketing a line of new burners to different industries.

International Experience

Metal 7 Inc. has extended its international sales in the early 1980s to the extent that now, it is exporting more than 50% of its production all around the world, including the US, Sweden, the Netherlands and India. It plans to expand its sales to Liberia, Mexico and Turkey.

For Further Information:

Mr. Charles Bigonnesse, General Manager or
Mr. Denis Belley, Engineering Department
Metal 7 Inc.

P.O. Box 1590
285 des Pionniers
Sept-Iles, Quebec
Canada G4R 4X9

PHONE: 418-968-5822

FAX: 418-962-4534

TELEX: 051-8-4130

INDUSTRY - THERMAL SPRAY COATINGS

MONTREAL CARBIDE COMPANY LIMITED

Description

Montreal Carbide Company Limited is a Canadian owned company established in 1980. The manufacturing and Research & Development facilities, are located in Boucherville, Quebec. With a staff of nine they occupy 8600 square feet of laboratory and plant space. The head office is located in Saint-Bruno, Quebec.

Specialization

Montreal Carbide specializes in the manufacturing of advanced ceramic powders for plasma-spray coatings used to increase wear resistance on metal parts and components; the manufacture of powder injection devices; and the manufacture of monolithic carbide (WC and B₄C) wear-resistant parts and components.

Products

► Powders

Specialized powders for reactive plasma-spraying titanium diboride-in-metal matrix coatings are produced. These give the flexibility to vary both the concentration of titanium diboride and the composition of the metal matrix to achieve optimum performance for specific applications.

► Equipment:

A plasma-spray injection device, designed to improve the quality of coatings (e.g., density, micro-structure) and to reduce costs mainly by controlling over-spray. H.V.O. systems or thermal spraying of wear resistant

coatings.

Wear Parts:

Sandblast nozzles made of tungsten carbide and boron carbide.

International Experience

Products are sold throughout North America and Europe and are well known for their quality and performance.

For Further Information:

Contact:

Mr. Peter Kalisky
President
Montreal Carbide Company Limited
1500 E, Nobel
Boucherville, Quebec
Canada J4B 5H3

PHONE: 514-449-0147
FAX: 514-449-6101

INDUSTRY - WEAR RESISTANT PARTS & COATINGS

MPB TECHNOLOGIES INC.

Description

MPB Technologies Inc. was federally incorporated in 1976 to develop high-tech products and to conduct research in electromagnetics, telecommunications, lasers, fusion, electro-optics and space technology.

The company's strength lies in its 30 highly qualified scientists and engineers. It occupies a modern 60,000 square-foot building which houses a library, central computer facility, glass-blowing facility, laboratories and a production area.

To design and manufacture customized ceramic-based products and systems, the company has the following facilities.

- ▶ Centor high-temperature vacuum and control atmosphere furnace (2000°C);
- ▶ Lindberg 3-zone tube furnace (1200°C);
- ▶ Vacuum deposition station;
- ▶ Low-temperature glass vacuum furnace;
- ▶ Residual gas analyser and leak detector.

Specialization

In the area of advanced ceramics, MPB Technologies Inc. has developed reliable, high-temperature, vacuum-tight, hard-seal techniques for the bonding of several combinations of materials such as ceramic-to-ceramic and ceramic-to-metal (kovar, stainless steel, platinum, etc.) seals.

A typical example of direct application of the sealing technology is the alumina-ceramic based CO waveguide laser development by

MPB.

Other examples of sealing technology include low-temperature seals for many ceramic-to-glass interfaces where temperature-sensitive coatings are required.

Products and Services

MPB Technologies Inc. provides R&D as well as custom manufacturing facilities in hard seals as well as other high-tech products.

International Experience

MPB has established a worldwide customer base in the U.S. (NASA, Hughes Aircraft Co., Raytheon), Europe (Battelle in Germany, Laserlab in Norway, Marconi Avionics in the U.K.), and in Asia (University of Tokyo, Sony and Sumitomo in Japan).

For Further Information:

Dr. A. Bajsarowicz
MPB Technologies Inc.
1725 North Service Road
Trans-Canada Highway
Dorval, Quebec
Canada H9P 1J1

PHONE: 514-683-1490
FAX: 514-683-1727
TELEX: 05-823509
Cable: MPBTCAN (Montreal)

INDUSTRY - CERAMIC-TO-METAL & CERAMIC-TO-CERAMIC JOINING

MURATA ERIE N. A. LIMITED

Description

Murata Erie N. A. Limited, a Canadian company, is part of Murata Erie N. A. Inc., which has its head offices in the U. S. It draws on more than 50 years of experience in the electronic component industry and has been manufacturing ceramic-based electromagnetic interference (EMI) filters at its Trenton, Ontario facility for more than 30 years.

The company has a well-established in house design and manufacturing facility with military-approved quality assurance/quality control (QA/QC) test facilities and modern production equipment. State of the art equipment is used in ceramic capacitor research and development.

The Canadian operations of Murata Erie employ about 600 people.

Specialization

Murata Erie N. A. Limited manufactures ceramic capacitors in several specialized configurations including tubular capacitors, discoidal capacitors and (multi-hole) planar capacitors. These are assembled into major products: low-pass filters and filtered connectors used for the suppression of electromagnetic interference (EMI). They are used in the medical, communications, commercial, military and aerospace industries.

Products

Products manufactured by Murata Erie include:

- ▶ low-pass EMI filters;
- ▶ filtered connectors and filter arrays.

International Experience

Murata Erie N. A. Limited has sales offices throughout North America and is represented worldwide by Murata Manufacturing Company (its parent company) and its various subsidiaries, sales offices and distributors. Murata Manufacturing Company is the world's leading supplier of electronic ceramics.

For Further Information:

Contact:

R. A. Verhagen
Trenton Operations
Murata Erie N. A. Limited
5 Fraser Avenue
Trenton, Ontario
Canada K8V 5S1

PHONE: 613-392-2581
FAX: 613-392-0701
TELEX: 06-62279

INDUSTRY - MANUFACTURER OF ELECTRONIC CERAMICS

NATIONAL COATING TECHNOLOGIES INC.

Description

National Coating Technologies Inc. was established in 1990 after acquiring assets of Plasma & Flame Coatings Limited. Their main line of business is coating of metallic parts. They occupy 18,000 square feet of plant space and employ 12 people.

Specialization

They specialize in plasma and flame sprayed coatings for heat, wear and corrosion resistant applications for the aerospace, petrochemical, pulp and paper, mining and machinery industries. In addition, the company manufactures original parts and components, including pump sleeves and patented ceramic coated wear strips (Uhle box rods) for the paper industry. The company also provides on-site coating services to the pulp and paper, mining and other industries.

International Experience

NCTI exports approximately 20% of sales to the United States. The U.S. purchases mostly ceramic coated wear strips (Uhle box rods) for the paper industry, through contracted U.S. distributors.

For Further Information:

President: Robert N. Logan

Contact:

John Reid
Vice President & General Manager
National Coating Technologies Inc.
1975 Logan Avenue
Winnipeg, Manitoba
R2R 0H8

PHONE: 204-632-5585
FAX: 204-694-3282

INDUSTRY - CERAMIC COATINGS

NATIONAL ELECTRICAL CARBON CANADA

Description

National Electrical Carbon Canada is a Division of Morganite Canada Corporation, a Morgan Group Company of the Morgan Crucible Company., plc Windsor, U.K. The company was founded in 1942 and are manufacturers of carbon products for electrical and mechanical maintenance and OEM applications. Major markets include all resource industries such as Pulp & Paper, Foundry & Steel Industries as well as the Rail Road and Transit authorities, utilities and general manufacturing industries.

Specialization

- ▶ A highly specialized selection of carbon brush grades that will provide consistent, problem free operation for today's demanding performance requirements.
- ▶ A complete line of replacement brushholders in both conventional and constant pressure styles.
- ▶ A wide selection of "mechanical carbon" components, including high technical ceramic materials such as silicon carbide, filled PTFE and graphite.
- ▶ Porous Carbons for ultra filtration of metals and other special liquid/solid separation needs.
- ▶ Carbon & Graphite Cloth & Felts for use in heat containment & induction heating applications.
- ▶ Coke Particles & Flours used in composite materials manufacturing for products such as clutch plates and brake shoes.
- ▶ Carbon Raschig Rings for liquid/gas and gas/gas stripping tower applications.
- ▶ Hi-purity Extruded Graphites for use in the processing industries requiring low

levels of impurities.

- ▶ Agricultural components manufactured by Morgan include Ceramic seed coulters and hoe points.
- ▶ Morganite carbon current collectors are designed for operation on conductors formed by wires or rails and are suitable for both interior and exterior applications.
- ▶ Electrical carbon contacts are manufactured in a large variety of shapes & sizes and materials to suit many applications.

Power Diodes and Thyristors

These products range from SCR's and Power Diodes, to Solid State Relays and encapsulated assemblies or Power Cubes, which are available in a variety of circuit configurations.

International Links

The Morgan Group spans the world with over 120 companies in 31 countries and selling into over 124. Its operations stretch from Dalian, Osaka, Seoul, Kaohsing & Sydney in the East, and to Los Angeles, Mexico City, Caracas, Sao Paulo and Toronto in the West.

For Further Information:

President/CEO:

Mr. W.E. Macfarlane
National Electrical Carbon Canada
6300 Northam Drive
Mississauga, Ontario
Canada L4V1H7

PHONE: 416-678-6660

FAX: 416-678-6448

INDUSTRY - MANUFACTURES OF CARBON PRODUCTS FOR ELECTRICAL AND MECHANICAL MAINTENANCE & OEM APPLICATIONS. PARENT COMPANY IS A MAJOR WORLD SUPPLIER OF CERAMICS.

NEOSID (CANADA) LIMITED

Description

Neosid (Canada) Limited is one of the members of the Magnetic Materials Group PLC companies of the United Kingdom. In the production of electronic cores since 1952, at first NCL produced only powdered iron cores and then, in the 1960s, added the production of ferrite cores. This mix of core types is still in active production and has recently been expanded to take advantage of new materials developed by the Magnetic Materials Group.

The original facilities have recently been expanded to house larger office and laboratory facilities. At present, the company employs 19 people.

Specialization

Neosid (Canada) Limited specializes in the manufacture of ferrite electronic cores for use in inductive applications as well as in noise suppression, power, telephone and energy storage applications.

Products

Products manufactured are:

- ▶ different types of cores: powdered iron E-cores, hollow cores, insert cores, rods, etc.;
- ▶ choke forms;
- ▶ ferrite beads and toroidal cores;
- ▶ magnetic components for the electronic industry.

Products manufactured by other members of Magnetic Materials Group include permanent magnets for the electrical/electronic industry.

International Experience

Although Canadian production is primarily for the domestic and U.S. markets, there is some export to South American countries, Australia and Europe.

For Further Information:

Mr. Alan S. Lloyd
Vice President Operations

Contact:

Sandra Allan
Sales Manager/Marketing Manager
Neosid (Canada) Limited
10 Vansco Road
Toronto, Ontario
Canada M8Z 5J4

PHONE: 416-251-2831
FAX: 416-251-6790

INDUSTRY - FERRITE ELECTRONIC CORES

NORTHERN PIGMENT COMPANY

Description

Northern Pigment started its operations in the 1920s and was acquired by the Canadian Corporate Management Company Limited in 1945. Recently, CCM merged with Federal Industries, a diversified Canadian company. It is now a division of Federal Industries, Industrial Group Inc.

The company about 75 to 100 people, including 15 technical staff.

Specialization

Northern Pigment manufactures synthetic iron oxides for two different markets.

- ▶ iron oxide pigments used as colourants for coatings, plastics and concrete products;
- ▶ special iron oxides used in the manufacture of advanced ceramic magnetic products.

Products

The company produces a range of natural and synthetic oxide pigments comprising over 50 distinctive colour shades from yellow to red, brown, green and black, and a range of iron oxides used in the manufacture of advanced ceramic magnetic products.

International Experience

Northern Pigment markets its products internationally.

For Further Information:

President: J. M. Cooke, President

Vice-President - Operations

W. H. Nord

Manager, Sales & Marketing

R. DeMarchi

Manager, R&D

P. Duncker

Northern Pigment Company
36 Towns Road
Toronto, Ontario
Canada M8Z 1A3

PHONE: 416-251-1161

FAX: 416-251-4774

INDUSTRY - IRON OXIDE PIGMENT AND MAGNETIC PRODUCTS

ONTARIO HYDRO

Description

Ontario Hydro, a Crown Corporation, is one of the largest producers of electrical energy for Ontario. Founded in 1913 it now employs 24,000 people and its transmission and distribution network spans all parts of the province.

Specialization

The Ontario Hydro Research Division provides technical and Research & Development support in the generation, distribution and use of electric power. In the area of advanced ceramics it works to develop new electrotechnologies which can be used by Ontario industry to improve their efficiency and competitive position. Wise use of electrical energy is always a guiding principle.

Products and Services

The main product of interest is the supply of economical and reliable electric power for the manufacturing industries. The Advanced Ceramics group is working on the development of plasma to provide advanced ceramic powders and coatings, microwave drying and sintering process technologies.

As well, the Ontario Hydro's large research capability, which spans electrical, metallurgical, chemical, mechanical and civil engineering, is available to the ceramics industry for the development of electrotechnologies for processing advanced ceramic powders and components.

International Experience

Have developed a New Business Ventures Division.

For Further Information:

President/CEO: Mr. R. Franklin

Contact:

Dr. C. J. Simpson
Special Projects
Ontario Hydro
800 Kipling Avenue
Toronto, Ontario
Canada M8Z 5S4

PHONE: 416-231-4111
FAX: 416-231-9679
TELEX: 06-984706

INDUSTRY - POWER GENERATION; MICROWAVE PROCESSING OF ADVANCED CERAMICS

ORTECH INTERNATIONAL

Description

ORTECH International is a comprehensive technology consulting company serving commercial organizations and government. It works with clients to develop improvements and innovations in products and processes.

The company was established in 1928 and employs 350 people. ORTECH has a subsidiary, ORDCO Technology Limited, a dormant company involved in technology transfer.

Areas of expertise include materials (ceramics, metals, plastics, polymers and composites), materials processing, environmental technologies (resource recovery, effluent control technologies and occupational health) and engine technology (alternate fuels). In addition, a comprehensive range of testing equipment is available to provide test services out of the context of research and development projects.

Specialization

ORTECH provides research and development and specialized services on a contract basis in glass and ceramic studies. It has established its expertise over three decades to become one of the leading organizations in this area in Canada. Areas of specialization relevant to glass and ceramics include the following:

- ▶ fine powder preparation and processing
- ▶ sol gel technology
- ▶ forming and sintering
- ▶ coating technologies (including diamond and plasma)
- ▶ prototype development
- ▶ materials characterization
- ▶ mechanical and thermal property measurement (including thermal dilatometric analysis)
- ▶ composite preparation technology
- ▶ optical fibre technology

- ▶ glass and ceramic to metal sealing
- ▶ piezoelectric and ferroelectric ceramics
- ▶ materials processing in microgravity.

Services

- ▶ process/product development: the company provides technology research to increase product performance and markets and performs pre-production feasibility studies.
- ▶ problem solving and testing: project teams investigate the cause of problems using a comprehensive range of laboratory scale and pilot scale equipment and instruments.
- ▶ systems consulting: available to both the public and private sector, the consultation process involves feasibility studies, technology assessments, equipment selection, evaluation and pilot scale production studies.
- ▶ technology transfer: the company facilitates transfer of new developments from the laboratory to industrial production, both within and across industry sectors.

International Experience

The client base of Ortech is worldwide with a network of companion organizations throughout North America, Europe and Asia. The net result is a global perspective in its information programs and consulting projects.

For Further Information:

President: Mr. Ross Lawford

Contact: L.M. Luckevich

Inorganic Materials

Ortech International

2395 Speakman Drive

Mississauga, Ontario

Canada L5K 1B3

PHONE: 416-822-4111

FAX: 416-832-1446

INDUSTRY - CONTRACT RESEARCH & DEVELOPMENT

PEACOCK INC.

Description

Peacock Inc. is a Canadian company founded in 1897. Its Industrial Products Division manufactures and distributes filtration products, material handling equipment, pumps and instruments of all types. Its Industrial Services Division operates six fully equipped service centres in Montreal, Toronto, Calgary, Edmonton, Fort St. John and Fort McMurray. These provide around-the-clock specialized repair and rebuild service for a wide range of industrial equipment.

- ▷ specialty grinding and super finishing;
- ▷ machinery repairs and rebuilds;
- ▷ industrial repairs and rebuilds custom parts;
- ▷ machinery field service;
- ▷ bearing babbit by static pouring;
- ▷ flame spraying and centrifugal casting;
- ▷ plasma, Jet Kote, Thermo, wire.

Specialization

Peacock Inc. specializes in the application of plasma flame spray and combustion rod methods to deposit ceramic coatings on metal parts and components to achieve thermal barrier, wear and abrasion resistance, and high-dielectric strength properties. The ceramic coating materials generally used are aluminum oxide, titanium dioxide (and blends of these), Chromium oxide, zircon and magnesium zirconate.

For Further Information:

General Manager
Peacock Inc.
1180 Aerowood Drive
Mississauga, Ontario
Canada L4Z 1Y5

PHONE: 416-625-7100
FAX: 416-625-7203
TELEX: 06-961291

Products and Services

Peacock's products include pumps and valves, filtration systems, material handling systems, filter replacement cartridges and measuring devices of all kinds.

The following services in advanced ceramic coatings are provided:

- ▷ plasma-transferred arc welding;
- ▷ flame spray systems;
- ▷ hard surfacing;

INDUSTRY - ADVANCED CERAMIC COATINGS ON METALS

POLY CERAM INC.

Description

Founded in 1975 by a group of scientists, Polyceram Inc. is a high-technology ceramics company which develops and produces specialty ceramic products for use by engineers and scientists. The company has a total staff complement of three.

Specialization

The company specializes in the production of high-density, high-purity ceramic crucibles for use in high-temperature containment of metals, slags, salts, oxides; for use as ceramic solid electrolytes; for high-temperature assays; for thermodynamic measurements, and as solid ion-selective membranes.

Products

The following products are made by Polyceram:

- ▶ magnesia products: for use in containing corrosive melts such as basic slags, oxides, salts or metals;
- ▶ calcium fluoride products: for containing molten metals when thermodynamic stability and minimum contamination are essential. They can also be used for solid electrolyte applications;
- ▶ beta-alumina: applications for these products include probes and electrochemical sensors for on-line chemical analysis, thermodynamic measurements etc.

For Further Information:

President: Dr. Alain Dubreuil

Polyceram Inc.
P.O. Box 6079, Branch A
Montreal, Quebec
Canada H3C 3A7

PHONE: 514-340-4988
FAX: 514-340-4026
TELEX: 05-24146

INDUSTRY - PRODUCER OF HIGH-PURITY CERAMIC CRUCIBLES

POWERLASERS LIMITED

Description

Powerlasers Limited was founded in 1976 and is a privately held research and development company. It employs close to 10 individuals and has annual sales between \$250,000 and \$1 million in the LBOE field. Powerlasers clientele consists of small and large companies and government agencies in Canada, the US and Asia. Powerlasers Limited has several cooperation agreements with government agencies and firms such as General Motors Corporation which provide the company with financial and manufacturing assistance.

Specialization

Powerlasers Limited has devised and patented a process for high efficiency laser processing of metals. This highly innovative surface pre-treatment technique increases the energy efficiency of laser cutting, welding and heat treating by more than 60%. Thermal characteristics of such surfaces can be tailored for enhanced radioactive emission and absorption.

Surface treatment techniques finds application in three major fields:

- ▶ Aerospace Industry: Specially prepared surfaces are used as highly efficient thermal radiators. Powerlaser's surfaces retain their superior thermal characteristic under very adverse conditions such as extremely high temperatures (2000-3000°C) and oxidizing environments.
- ▶ Laser Machining: Thermal response of a metal surface can be tailored to achieve high absorptivity in I.R. wavelengths. This means energy efficiency of processes such as laser

cutting and welding can be increased dramatically.

- ▶ Solar Energy: Highly efficient solar collectors can be prepared by using our surface treatment technique.

Products:

1. Metal Surface Modification with Lasers
2. Laser Materials Processing Systems
3. 3-Dimensional Shape Formation on Foam Using Lasers

International Experience:

Powerlasers is seeking foreign cooperation in the areas of investment and the rights to sell foreign products in Canada. Powerlasers is offering foreign firms research technology, know-how and the rights to sell Powerlasers products abroad. The company is also willing to participate in joint activities in the areas of personnel exchange, shared R&D, product development and the marketing of joint items.

For Further Information:

President: Dr. W. W. Duley

Contact:

Dr. M. Ogmen
Powerlasers Limited
2700 Steeles Avenue West
Suite 204
Concord, Ontario
Canada L4K 3C8

PHONE: 416-660-7599

INDUSTRY - LASER PROCESSING

PRATT & WHITNEY CANADA

Description

Pratt & Whitney Canada (P&WC) was founded in 1928 as the Canadian sales and service centre for Pratt & Whitney engines, manufactured in the USA. The company currently employs 9,500 people in three Canadian provinces. In 1951 the Canadian company began its own manufacturing. A leading manufacturer of gas turbine engines for the regional transport and general aviation markets, P&WC has a world mandate to design, develop, manufacture, market, and support turboprop and turboshaft engines, small turbofan engines, and auxiliary power units.

Specialization

The company currently manufactures five engine families: the PT6 turboprop/turboshaft; the JT15D turbofan; the PW100 turboprop; the PW300 turbofan; and the PW901A auxiliary power unit (APU).

They are currently developing a new family of turboshaft engines for light and medium helicopters, the PW200. The first model in this series, the PW205B, successfully completed its first flight in 1988, powering Messerschmitt-Bolkow-Blohm's BO 105 LS twin-engine helicopter. To date, the PW200 program has accumulated more than 4,000 hours in development testing. In 1989, McDonnell Douglas became the launch customer for P&WC's PW200 program with the selection of the PW206A turboshaft to power its new-generation MDX helicopter.

The PW300, a new turbofan series in the 4,500 - to 6,000 pound thrust class, is being developed by P&WC in collaboration with Motoren - and Turbinen-Union Munchen (MTU) of West Germany. Designed for the next generation of mid-size intercontinental/transcontinental business jets, the PW300 was launched in 1986.

The engine, scheduled for certification in the second half of 1990, was selected by British Aerospace (BAe) in 1989 to power the BAe 1000. The new mid-size twin-engine aircraft successfully completed its first public flight in June 1990 in Chester, England. The PW300 has also been selected by Volpar Aircraft to retrofit the Dassault-Breguet Falcon 20 corporate jet.

P&WC's Industrial & Marine Division provides gas turbine products and systems for use in large electrical generating sets, gas pipeline compressor sets, and marine propulsion systems. The ST6 turboshaft engine is an industrial application of the PT6. Research continues into the application of ceramic materials in gas turbine engines.

International Experience

P&WC's global overhaul and service organization features a network of three service centres and nine regional centres, as well as some 20 authorized overhaul centres around the world. P&WC's service centre organization employs more than 1,500 people. To date, the company has delivered 34,000 gas turbine engines, which have accumulated 188 million flying hours on some 15,000 aircraft in 150 countries.

For Further Information:

President: Mr. David L. Caplan

Contact:

Andre L. Neuburger, M. Eng.

Senior Technical Consultant

Advanced Design

United Technologies

Pratt & Whitney Canada Inc.

1000 Marie-Victorin

Longueuil, Quebec

Canada J4G 1A1

PHONE: 514-677-9411

FAX: 514-647-7652

INDUSTRY -- GENERAL & REGIONAL AVIATION POWER PLANTS

QUALITY HERMETICS COMPANY (1990) INC.

Description

Founded in 1955, Quality Hermetics Company was acquired by Leigh Instruments Limited in 1969, and subsequently purchased from the assets of Leigh Instruments Limited and re-established as Quality Hermetics Company (1990) Inc. It is unique in Canada as the only wholly Canadian owned manufacturer of glass and glass-ceramic hermetically sealed components. Because of its specialized capabilities and quality products, it has developed a customer base in Canada, the U.S. and Europe. The total staff numbers 16.

More than a decade, this company has been researching and developing the design of new glass-metal and glass-ceramic-metal seals. This work, which was supported by both federal and provincial governments, has resulted in unique capabilities and a large number of novel product lines. The most noteworthy products are radiation-resistant hermetic seals developed for Atomic Energy of Canada, as well as other nuclear power generating facilities in the U.S.; specialized 16-pin electrical connectors for deep-hole oil and gas exploration; and special connectors for aircraft guidance systems.

As a long-term growth strategy, Quality Hermetics Company (1990) Inc. is committed to research and development of new technologies and products. Currently, it is developing new advanced glass-ceramic materials with technical and financial support from a number of government agencies, particularly the National Research Council of Canada.

Specialization

Quality Hermetics Company (1990) Inc. specializes in the design and manufacture of hermetic feedthrus, stand-offs, connectors, headers, crystal and oscillator bases. The company has a proven capability for developing

advanced glass and glass-ceramic sealing materials to withstand a variety of hostile environments. It can also provide custom sealing to suit specific customer requirements.

Products

Hermetically sealed products manufactured by the company include:

- ▶ radiation-resistant headers and connectors used in nuclear power generation.
- ▶ high-pressure connectors, using advanced glass ceramics, to withstand 30,000 psi pressure, for deep-hole drilling in oil and gas exploration.
- ▶ rack and panel connectors for aerospace applications.
- ▶ miniature feedthrus and stand-offs for aerospace and communication equipment.
- ▶ multi-terminal headers for high-vacuum applications.
- ▶ hybrid packages for the microelectronics market.

International Experience

Up to the present, Quality Hermetics Company (1990) Inc. has concentrated on the Canadian and North American markets with representatives in California, New York, New Jersey, Massachusetts, Minnesota and Western Canada; it is now entering markets in Europe and the United Kingdom.

For Further Information:

President: Mr. Keith Elliott

Contact: Mr. Anthony DeSantis, Vice President
Quality Hermetics Company (1990) Inc.

45 Hollinger Road

Toronto, Ontario

Canada M4B 3G4

PHONE: 416-288-1282

FAX: 416-288-1350

INDUSTRY - MANUFACTURER OF HERMETIC FEEDTHRUS, CONNECTORS, HEADERS; GLASS AND GLASS-CERAMIC OR SEALING MATERIALS

SEASTAR OPTICS DIVISION

Description

Seastar is a small, highly focused technology company with a rapidly expanding production capability and client base worldwide. Founded in 1984, Seastar is a privately held company with Seakem Group Limited as its parent company. The company has two subsidiaries called Seastar Instruments Inc. and Seastar Instruments Limited located in Seattle, Washington and Dartmouth, Nova Scotia respectively.

Seastar employs between 11 and 50 employees and has annual sales between \$1M and \$5M. Of the total sales LBOE contributes between \$250,000 and \$1M. Clientele consists of large companies, government agencies and universities/research labs in the US, Europe and Western Pacific Rim countries.

Specialization

Seastar Optics Division, part of Seastar Instruments Limited, has developed production technology for bonding semiconductor laser diodes to singlemode, multimode and polarization preserving optical fibres. This process is crucial for fibre-optic communications and sensors. They have developed the first (commercial) ultra stable current sources for operating laser diodes, and recently developed a highly regulated temperature controller for maintaining and setting the temperature of laser diodes.

Products:

1. Pigtailed and Connectorized Laser Diodes
2. Stabilized Current Drivers for Laser Diodes
3. Temperature Controller for Laser Diodes

International Experience

Seastar is currently working on establishing cooperation links with the US Optical Research Company, the National Optics Institute and the Technical University of Warsaw to provide R&D and engineering for Seastar product developments. They are seeking foreign cooperation in the areas of investment and the production of foreign products in Canada. Seastar is offering the rights to sell Seastar products abroad to foreign firms. The company is also willing to participate in shared R&D and joint product development.

For Further Information:

Contact:

Mr. Peter G. Berrang, President
Seastar Optics Division
P.O. Box 2430
2045 Mills Road
Sidney, B.C.
Canada V8L 3S1

PHONE: 604-656-0891
FAX: 604-655-3435
TELEX: 049-7526

INDUSTRY - BONDING SEMICONDUCTOR LASER DIODES

SHAW INDUSTRIES LIMITED

Description

Shaw Industries Limited, is a Canadian public company, specializing in products and services for the energy and resource industries. As one of the first participants in the Canadian pipeline construction industry, Shaw Industries was able to perceive the potential advantages inherent with the utilization of improved materials and processes for coating pipe to prevent corrosion.

Shaw Industries has grown through expansion and diversification. In 1969 Shaw Industries expanded and diversified beyond pipe coating, through the development of a broad range of specialty products including wire and cable, hose and tubing, heat shrinkable plastics and wooden cable reels. Today, the company operates on a worldwide basis with plants located in Canada, the United States, Great Britain and Australia.

Specialization

The company is organized into three business units:

- ▶ Pipeline and Tubular Products include corrosion and other coatings for pipelines as well as inspection, testing and repair services for drill pipe, tubing, casing and line pipe used for exploration, production and gathering of oil and gas.
- ▶ Resource Products include geophones, cables, connectors and accessories for use in seismic exploration and drill string components used in the drilling of oil, gas and water wells.

- ▶ Electrical Products include wire, cable and tubing for use in process instrumentation and control systems as well as broad range of thermoplastic hydraulic hose and tubing used primarily on industrial and transportation equipment. Other products include specialized heat shrink tubing used in electrical and electronic applications as well as wooden reels used in the wire rope industries.
- ▶ Shaw's interest in ceramic materials is for corrosion and abrasion resistance coatings.

International Experience

The foreign geographic segment includes operations in the United States, Australia and the United Kingdom. In addition to these permanent installations, temporary project-specific plants are installed anywhere in the world as circumstances demand.

For Further Information:

President: G. F. Hyland

Chairman & CEO: L. E. Shaw

Contact:

R. E. Steele, Ph.D.
Director of Technology & Development
Electrical Products
Shaw Industries Limited
25 Bethridge Road
Rexdale, Ontario.
Canada M9W 1M7

PHONE: 416-743-7111
FAX: 416-743-7199

INDUSTRY - PIPELINE COATINGS, TUBULAR PRODUCTS, OIL FIELD
INSTRUMENTATION PRODUCTS

SHERITT GORDON LIMITED 'WESTAIM'

Description

Westaim Technologies Inc. is a subsidiary of Sherritt Gordon Limited dedicated to the development and commercialization of new advanced industrial materials for application in the aerospace, electronic and process industries. Ceramic materials are one of the areas targeted for business growth.

They represent the cooperative commitment of the governments of Canada and Alberta, and Sherritt Gordon Limited to the development of advanced materials in Alberta. Westaim got underway in 1990 and the first five years of operation will be funded by industry and government to a total of 140 M\$.

Specialization

Sherritt has a history of successfully commercializing advanced industrial materials. Since Sherritt began operations in 1927, over 100 distinct products and processes have been commercialized by Sherritt. This involved the registration of about 2600 patents worldwide. Today, Sherritt exports a wide range of specialized metal powders and products to the aerospace, electronic and process industries of the world.

Westaim recognizes the importance of alliances to the expedient commercialization of new materials. In addition to capitalizing on the experience of Sherritt, Westaim is actively seeking and developing alliances with other companies, universities and research institutes. Westaim has been structured to facilitate and encourage the formation of strong alliances for the development of technology and markets.

Westaim has identified ceramic material as a natural extension of Sherritt's current product

lines. Westaim intends to utilize Sherritt's current product lines. Westaim intends to utilize Sherritt's established expertise in chemical processing, powdered metals and marketing of specialized materials to help it develop new products based on ceramics. A team of ceramists and market specialists is utilizing new Westaim facilities to develop significant new ceramics businesses in Alberta.

For Further Information:

President: Dr. D. R. Wier

Contact:

Mr. Brad Palmer
Principal Researcher, Ceramics
Westaim Developing Advanced
Industrial Materials
Westaim Technologies Inc.
Fort Saskatchewan, Alberta
Canada T8L 3W4

PHONE: 403-992-5089

FAX: 403-992-5010

**INDUSTRY -- RESEARCH & DEVELOPMENT FOR COMERCIALIZATION OF
ADVANCED INDUSTRIAL MATERIALS**

STANDARD AERO LIMITED

Description

Established in 1938 Standard Aero Limited is a division of Hawker Siddely Inc. and employs 700 people. With its head offices and major overhaul facilities in Winnipeg, Standard Aero supports its Canadian customer base through service centres in Vancouver and Montreal.

Specialization

Standard Aero specializes in the overhaul and repair of aircraft, industrial gas turbine engines and airframe components. In advanced ceramics, it specializes in the application of plasma and flame-spray coatings in the repair and overhaul of gas turbine engines.

Services

Standard Aero provides a complete range of repair and overhaul services for gas turbine engines including:

- ▶ Allison 250 series;
- ▶ Allison T56/501 series;
- ▶ Allison 501-K Industrial series;
- ▶ General Electric T58 series;
- ▶ Lycoming/Textron T53/T55 series;
- ▶ P & W PT6A series.

The company has in-house plasma-spray and flame-spray coating facilities which are used in the overhaul of gas turbine components.

International Experience

An international operations group in Redmond, WA, markets the company's products and services throughout the Pacific Rim countries. European activities are supported through a branch office in London, England.

The U.S. market is serviced from centres in Charlotte, NC, Dallas, TX and Van Nuys, CA.

For Further Information:

President/CEO: Bob Hamaburg

Contact:

Brent Junkin
Engineering Technical Service
Standard Aero Limited
33 Allen Dyne Road
Winnipeg, Manitoba
Canada R3H 1A1

PHONE: 204-775-9711
FAX: 204-783-5686
TELEX: 07-57878

INDUSTRY - GAS TURBINE ENGINE REPAIR OVERHAUL
PLASMA AND FLAME - SPRAY COATINGS

SYNCRUDE CANADA LIMITED

Description

Established in 1964, Syncrude Canada Limited operates the largest synthetic crude oil production facility in the world. Syncrude's corporate headquarters are located in Fort McMurray and employs 4,600 people. The oil sands plant is located 40 kilometres north of Fort McMurray and produces 10% of Canada's total oil requirements.

Syncrude is a consortium owned by:

- Esso Resources Canada Ltd. 25 %
- Petro-Canada Inc. 17 %
- Alberta Oil Sands Equity 16.74 %
- Pan Canadian Petroleum Ltd. 10 %
- Alberta Energy Company Ltd. 10 %
- Gulf Canada Resources Ltd. 9.03 %
- Canadian Occidental Petroleum Ltd. 7.23 %
- AMOCO Canada Petroleum Company Ltd. 5 %

Specialization

Their function is to produce synthetic crude oil from the Athabasca Oil Sands for its owners safely, reliably and efficiently. It has one of the largest industrial research facilities in Western Canada. Syncrude has 102 Canadian patents and 84 in the U.S.A. They are involved in joint research projects with AOSTRA and CANMET.

The Athabasca oil sands on which Syncrude is located, is the world's largest single deposit containing an estimated 870 billion barrels of heavy oil and bitumen. Approximately 10% of this is believed recoverable through surface mining.

Syncrude mines the oil sand from an open pit mine, extracts the bitumen (as the raw oil is called) using steam and hot water, and upgrades it into synthetic crude oil by fluid coking, hydrocracking, hydrotreating and reblending. The synthetic crude oil is sent down a pipeline to Edmonton and then to refineries.

For Further Information:

President/CEO: Mr. E. P. Newell

Contact:

Dr. J. K. Liu
Syncrude Canada Limited
Research Department
P.O. Box 5790, Station L
Edmonton, Alberta
Canada T6C 4G3

PHONE: 403-790-5911 (Site)
403-464-8523 (Research)
FAX: 403-464-8405 (Research)
TELEX: 037-2302

INDUSTRY - SYNTHETIC CRUDE OIL FROM OIL SANDS

TECRAD INC.

Description

Tecrad Inc. was founded in 1982, and is a privately held company that employs between 51 and 100 individuals and has annual sales between \$1M and \$5M in the LBOE industry. They have several cooperative agreements with university research centres and government agencies such as the National Research Council of Canada (Industrial) and Energy, Mines and Resources Canada (CANMET Division) which provide the company with financial and R&D assistance to develop products.

Specialization

Tecrad designs, manufactures and markets a wide range of electronic equipment for evaluating and controlling the quality of metals and other materials, through non-destructive tests. Tecrad technology uses Eddy currents, ultrasounds and laser generated ultrasounds.

Since 1986, Tecrad has developed equipment based on ultrasounds, and later, a new approach using laser generated ultrasounds was designed to detect defects on composite materials. These new technological developments are used in the aeronautic, nuclear and industrial fields.

Products:

1. Laser Ultrasonic Inspection Technology Development
2. Optical Probes for Ultrasound Detection

International Experience

Tecrad exports the vast majority of its products: 18% to the US, 55% to Europe and 9% to Asia. 18% of sales are made in the Canadian market. Tecrad's products are marketed in Europe and Asia, where distributors are used. Most of their clients are businesses operating on a national or international scale. Tecrad is currently looking for foreign firms to sell their products abroad.

For Further Information:

President: Mr. Bertrand Allard

Contact:

Mr. Louis Moreau
Tecrad Inc.
1000 ave. St. Jean Baptiste
Suite 105
Quebec City, Quebec
Canada G2E 5G5

PHONE: 418-871-3505
FAX: 418-871-5897
TELEX: 051-31679

INDUSTRY - NDE ELECTRONIC EQUIPMENT

VAC-AERO INTERNATIONAL INC.

Description

Vac-Aero International Inc. was originally established in 1959 by engineers with many years of experience in the Canadian aircraft industry to provide braze and heat-treatment facilities for metal components used by the aerospace industry. From its head office in Oakville, Ontario it operates two plants, the Ontario division in Oakville and the Quebec division in Montreal.

Specialization

The Quebec division of Vac-Aero International Inc. specializes in plasma and flame-coating services for wear, erosion, corrosion and thermal protection applications. Coating materials include ceramics, carbides, nickel, cobalt and molybdenum.

Services

The Ontario division provides services in vacuum thermal processing which include annealing and stress relieving; hardening and tempering; solution heat treating and aging; precipitation hardening; and sintering.

In advanced ceramics, the Quebec division provides coating services. Manual, semi-automatic and computer-controlled robotic plasma-coating techniques are used to achieve homogeneous coating deposits and uniform thickness. The division employs about 30 people.

In the aerospace industry, Vac-Aero provides coating services for gas turbine engine and airframe components; hot section thermal barrier coatings for combustion and after burner liners; and abradable seal coatings in high and

low-compressor casings. Customers include Pratt & Whitney Canada, Rolls Royce and Air Canada.

For Further Information:

Contact:

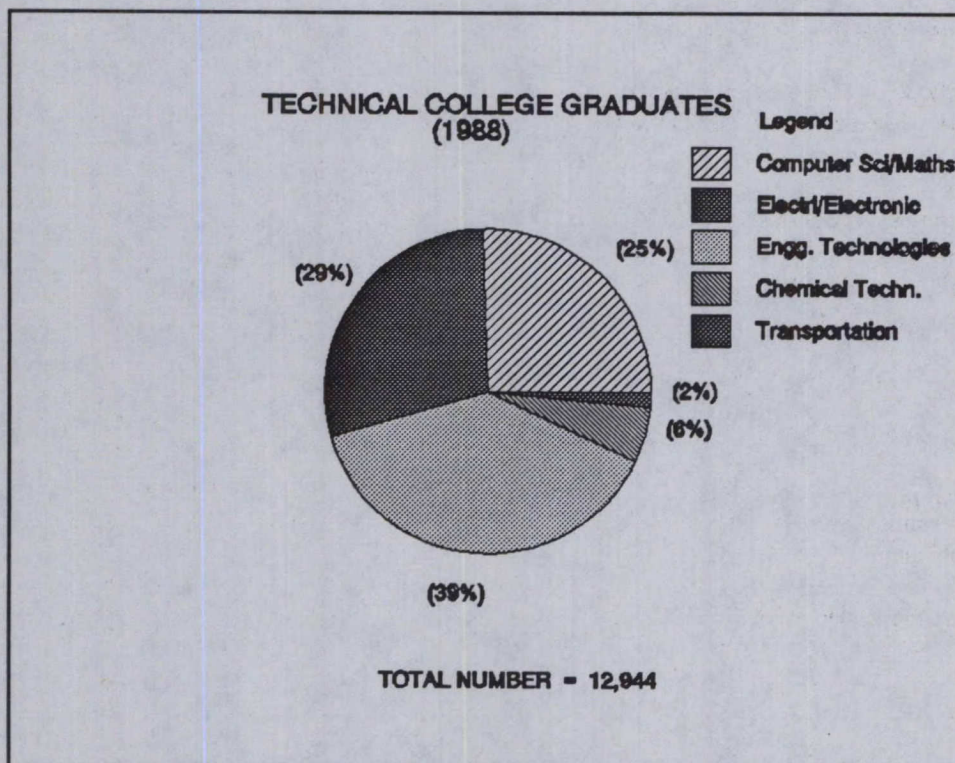
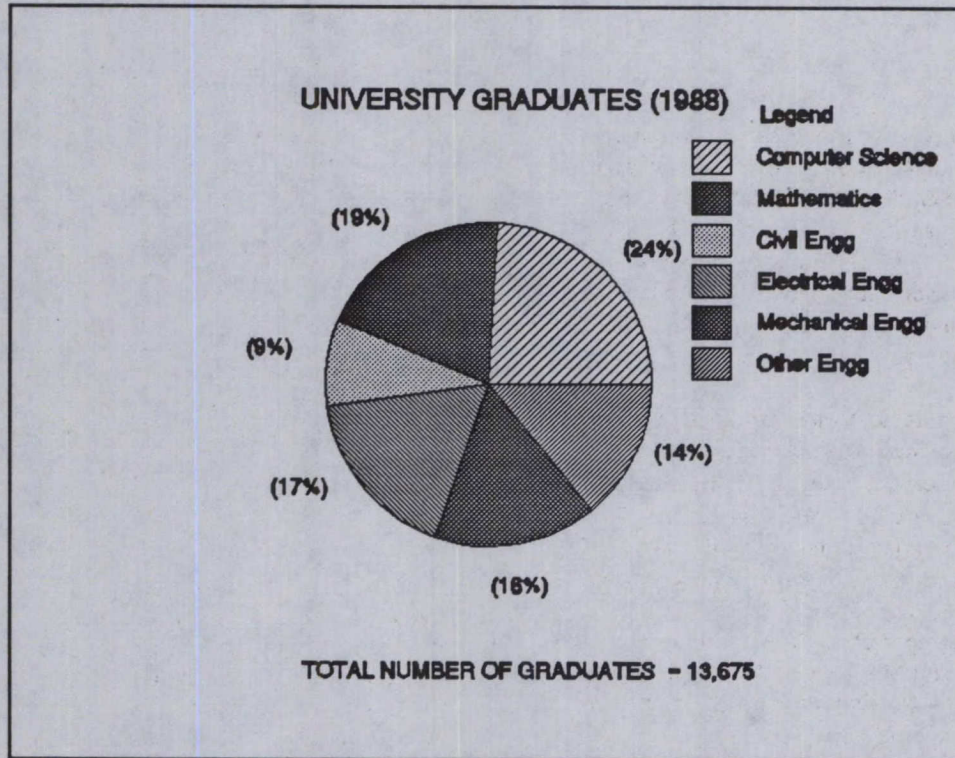
Mr. L. Gosselin
General Manager
Quebec Division Vac-Aero International Inc.
7450 Verite Quebec
Canada H4S 1C5

PHONE: 514-334-4240
TELEX: 05-824750

INDUSTRY -- PLASMA AND FLAME-COATING SERVICES,
VACUUM THERMAL PROCESSING

ACADEMIC INSTITUTIONS

CANADIAN TECHNICAL GRADUATES



CONCORDIA UNIVERSITY

Description

Concordia University provides undergraduate and graduate instruction in many fields related to ceramics including civil, mechanical and electrical engineering, physics and chemistry. There are 2329 engineering undergraduates, 1358 science undergraduates, 320 graduate students in engineering disciplines and 180 in science programs.

Although there is no formal program in ceramic engineering, related areas are covered by Centres of Research recognized by the Province of Quebec. These are the Laboratories for Inorganic Materials which offer MSc and PhD degrees in chemistry, physics and electrical engineering; the Institute for Composite Materials offering a PhD degree in mechanical engineering; and the Centre for Building Studies with a program leading to a Ph.D degree in building engineering.

Advanced Ceramics Research Programs

In the Laboratories for Inorganic Materials, 13 professors are working in the area of ceramic technology. Their subjects include:

- ▶ preparation, characterization of microporous ceramics as selective absorbents and catalyst matrices. (Dr. R. Le Van Mao);
- ▶ structural and electronic studies of ionic conductors as solid electrolytes (Drs. G. Denes and M. F. Bell);
- ▶ optical properties of ceramic glasses for laser applications (Dr. J. A. Capobianco);
- ▶ Electrochemistry of ceramic-ceramic interfaces (Dr. M. F. Bell);
- ▶ fabrication and characterization of thin film semiconductors such as GaAs (Dr. B. Lombos) and II-IV compounds (Dr. M. Lawrence);
- ▶ development of photovoltaic devices using II-VI semiconductors (Dr. M. F. Lawrence);
- ▶ physical properties (Mossbauer) (Dr. G. Denes) and electron spin resonance (Dr. S. Misra) of high T_c superconductors and their interfaces with solid electrolytes (Dr. M. F. Bell);
- ▶ protective thin films for biomedical implants (Dr. M. F. Bell);

Members of the group at other institutions include Dr. J. P. Dodelet (INRS) who is interested in semiconductor properties and Dr. J. F. Harrod (McGill) who is working on polysilanes and preceramics.

For Further Information:

Dr. C. H. Langford	514-848-3389
Dr. M. F. Bell	514-848-3387
Dr. J. A. Capobianco	514-848-3350
Dr. G. Denes	514-848-3346
Dr. M. F. Lawrence	514-848-3374
Dr. R. Le Van Mao	514-848-3343
Dr. B. A. Lombos	514-848-3085
Dr. S. Misra	514-848-3278

Laboratories for Inorganic Materials
Department of Chemistry & Biochemistry
Concordia University
1455 de Maisonneuve Blvd. West
Montreal, Quebec
Canada H3G 1M8

FAX: 514-848-3494

ACADEMIC INSTITUTION

DALHOUSIE UNIVERSITY

Description

Founded in 1818, Dalhousie University today has seven faculties: Arts and Science, Health Professions, Management Studies, Medicine, Law, Dentistry and Graduate Studies.

Cooperative arrangements exist between Dalhousie and the Technical University of Nova Scotia for programs in engineering, engineering-physics and computer science studies. The student enrollment is well over 10,000.

More than 70 percent of all funded research being conducted in Nova Scotia is performed at Dalhousie. The University has a Technology Transfer Office which provides close links with the business community.

Dalhousie does not offer a degree course in ceramics. The only advanced ceramics research activity is within the Division of Dental Biomaterials Science, which is part of the Department of Applied Oral Sciences in the Faculty of Dentistry, as well as being part of the Technical University of Nova/Scotia/Dalhousie University Biomedical Engineering Institute.

Advanced Ceramics Research Programs

Under the direction of Professor Derek W. Jones, the Division of Biomaterials Science is currently involved in the synthesis of glass-like materials. Colloidal silicate and sol-gel polymerization of alkoxides have been successfully used in producing glass spheres 0.03-0.04 mm in diameter, which can be used as glass fillers in composite systems and for polyalkenoate glass cement systems. Other R&D programs in place are:

- chemical stability of tetrasilicic-mica glass systems;

- role of moisture in the fracture of low-fusing glassfeldspathic biomaterials;
- mechanisms of failure of dental cement materials.

At present, two graduate students are pursuing research programs in ceramic biomaterials as part of their doctoral dissertation under the supervision of Professor Jones.

Other faculty members of the division active in biomaterials are Professor E.J. Sutlow and Dr. A.S. Rizkalla.

For Further Information:

Contact:

Dr. Derek Jones, PhD, FICeram, FRSC, FADM
Professor and Head
Division of Dental Biomaterials Science
Assistant Dean (Research)
Faculty of Dentistry
Dalhousie University
Halifax, N.S.
B3H 3J5

PHONE: 902-494-2274

ACADEMIC INSTITUTION

ECOLE POLYTECHNIQUE

Description

Ecole Polytechnique provides undergraduate and graduate curricula in many fields of engineering: civil, mechanical, electrical, chemical, metallurgy and materials, mining and geology, physical, industrial, energy and biomedical. The total enrollment is 3340 undergraduates and 980 graduate students.

The Department of Metallurgical Engineering offers programs in materials engineering leading to BEng, MSc and PhD degrees. Although there is no formal program leading to a diploma in ceramic engineering, nine graduate students are specializing in different aspects of ceramics for their research work. There are 76 undergraduates and 52 graduate students in metallurgical and materials engineering.

Advanced Ceramics Research Programs

There are 24 people presently working in ceramics: six professors, (Drs. J.P. Bailon, C. Bale, J.I. Dickson, J.M. Dorlot, A. Pelton and M. Rigaud), five research associates, two technicians and eleven graduate students.

Current interests of the group include:

- ▶ fracture mechanics and fatigue of ceramics and metals (Professors J.P. Bailon and J.I. Dickson);
- ▶ relationships between microstructure and mechanical strength of ceramics for structural applications (Professors J.I. Dickson and M. Rigaud);
- ▶ wear of bioceramics (Professor J.M. Dorlot);
- ▶ fabrication and application (as probes) of ceramic electrolytes such as beta aluminas (Professors A. Pelton and C. Bale);

- ▶ advanced refractories in high-temperature applications (Professor M. Rigaud);
- ▶ calculation of multicomponent ceramic phase diagrams and thermodynamic modelling of ceramic and glass phases (Professors A. Pelton and C. Bale).

Specific Research & Development contracts supported by government and industry include:

- ▶ development of Li and Na-probes for use in molten aluminum; development of Ca-conducting solid electrolytes for the steel industry;
- ▶ ceramic/ceramic composites; sintering of reinforced aluminas; development of partially stabilized zirconia nozzles for continuous casting of steel; thermal shock and chemical erosion resistance of carbon-bonded advanced refractories;
- ▶ fracture toughness of ceramics and carbon materials;
- ▶ calculation of phase diagrams of ceramic systems and thermodynamic modelling of ceramic and glass phases.

For Further Information:

Contact:

Dr. J. P. Bailon	514-340-4260
Dr. C. W. Bale	514-340-4770
Dr. J. I. Dickson	514-340-4963
Dr. J. M. Dorlot	514-340-4787
Dr. A. Pelton	514-340-4770
Dr. M. Rigaud	514-340-4253

Department of Metallurgical Engineering
University of Montreal Campus
P.O. Box 6079, Station A
Montreal, Quebec
Canada H3C 3A7
FAX: 514-340-4468

ACADEMIC INSTITUTION

LAVAL UNIVERSITY

Description

Established in 1852 Laval University provides undergraduate and graduate instruction in sciences, engineering, medicine, business, arts and humanities. The university has 24,600 undergraduates and 5,400 graduates at present.

Laval does not offer a degree program in ceramic engineering. However, ceramics is taught in the Department of Mining and Metallurgy in the Faculty of Sciences and Engineering. The department has a total of 128 undergraduate and 45 graduate students. Students can specialize in ceramics at the graduate level leading to MSc and PhD degrees.

Advanced Ceramics Research Programs

Dr. Roch Angers and Dr. Real Tremblay, in the Department of Mining and Metallurgy, are active in ceramics research. Their work, which is supported by both government and industry, includes:

- ▶ mechanical properties of structural ceramics;
- ▶ wear-resistant materials (WC, B₄C etc.);
- ▶ ceramic-ceramic composites (SiC/Al₂O₃).

For Further Information:

President/CEO:

Dr. Michel Gervais

Contact:

Dr. Roch Angers
Department of Mining and Metallurgy
Laval University
Ste. Foy, Quebec
Canada G1K 7P4

PHONE: 418-656-5385
FAX: 418-656-5343

Description

Established in 1821, McGill University is one of the oldest universities in Canada. Today, it has over 20,000 undergraduate and graduate students with 12 faculties (including Medicine, Engineering, Arts, Science and Agriculture) as well as 40 specialized centres and institutes.

Although McGill does not offer a formal degree program, in ceramics, undergraduate and graduate courses as well as research in ceramics are carried out in the Department of Mining and Metallurgical Engineering. Courses are offered in the traditional metallurgical subjects as well as ceramics, polymers and composites. The degrees offered are MEng and PhD.

Advanced Ceramics Research Programs

At present all the advanced ceramics R&D programs are carried out in the Department of Mining and Metallurgical Engineering. The interests of the Ceramics Group, which consists of two Professors, two Research Associates, one Research Assistant and seven graduate students, are in the processing and fabrication of advanced structural ceramics.

The industry or government-supported projects include:

- ▶ carbothermic production of Si_3N_4 and ALN powders;
- ▶ processing and sintering of Si_3N_4 ;
- ▶ mechanics of slip casting;
- ▶ ceramic-metal joining;
- ▶ Metal Matrix and Ceramic Matrix Composites;

- ▶ Research on Bonded Si_3N_4 Composites
- ▶ sintering of metal powders.

For Further Information:

Contact:

Dr. R. A. L. Drew
Dr. M. D. Pugh
Department of Mining and
Metallurgical Engineering
3450 University Street
Montreal, Quebec
Canada H3A 2A7

PHONE: 514-398-4350
FAX: 514-398-4492
TELEX 05-268510

MCMMASTER UNIVERSITY

Description

McMaster University provides undergraduate and graduate instruction in the sciences and engineering, medicine, business and arts and humanities. At present, the university has 13,445 undergraduates and 2180 graduates.

McMaster University is the only university in Canada offering a formal degree program in ceramics. Its Department of Materials Science and Engineering offers both under-graduate and graduate courses in ceramic engineering. However, only the undergraduate course leads to the formal BEng (Ceramic Eng) degree. At present, there are 40 undergraduates in ceramic engineering.

Graduate students may specialize in ceramics, materials engineering or metallurgy problems in programs leading to MEng and PhD degrees. At present, there are 15 graduate students specializing in advanced ceramics.

Advanced Ceramics Programs

The Advanced Ceramics Group at McMaster University is the largest in Canada, comprising three professors, eight research associates, five technicians and 15 graduate students. Professor Nicholson's interests include:

- ▶ spray-freeze/freeze-drying and ultrasonic spray pyrolysis superconductors;
- ▶ development of disappearing-liquid-phase techniques for enhanced densification of piezoelectric, superconductive and electrolytic ceramics;
- ▶ development of high-frequency ultrasonic techniques for non-destructive evaluation (NDE) of high-performance ceramics.

Specific R&D contracts supported by government and industry include: NDE of advanced ceramics by ultrasound; high power transducers from ALN; solid electrolytes (proton conducting) for fuel cells and high-cement density superconductors.

Professor Wilkinson's interests include:

- ▶ mechanical properties of ceramics and metals, particularly damage processes at elevated temperatures.

Government and industry-supported Research & Development contracts include: ceramic/ceramic composite damage and creep of alumina-based ceramic development and character of Si₃N₄ microstructures; and sintering of superconducting powders.

Professor Johari's interests include:

- ▶ properties of glasses, glass ceramics and glass melts;
- ▶ electronic ceramics (semiconducting and superconducting);
- ▶ glass-ceramic-polymer composites.

Specific R&D contracts supported by government and industry are: optical fibres; electronic ceramics (superconducting and semiconducting); UV absorption and mechanical properties of glass; glass/glass ceramic/polymer composites; and microgravity space processing of glassy materials.

For Further Information:

P.S. Nicholson (416)525-9140 Ext. 497

D.S. Wilkinson (416)525-9140 Ext. 429

G.P. Johari (416)525-9140 Ext. 494

Department of Materials Sci. & Engineering
McMaster University

1280 Main Street West

Hamilton, Ontario Canada L8S 4L7

PHONE: 416-525-9140

FAX: 416-528-5030

TELEX: 06-18347

ACADEMIC INSTITUTION

QUEEN'S UNIVERSITY

Description

Queen's University has undergraduate and graduate programs in the faculties of Arts and Science, Applied Science, Education, Medicine, Law and in the School of Business. The total undergraduate and graduate strengths of the university are maintained at about 11,000 and 1900, respectively.

No undergraduate degree is offered in ceramic engineering, although some courses in advanced ceramics and composite materials are available in the Department of Materials and Metallurgical Engineering. An option in materials science is offered as part of the Engineering Physics program in the Faculty of Applied Science.

The departments of Physics and Materials and Metallurgical Engineering offer graduate programs leading to MSc, MSc(Eng) and PhD degrees in research areas linked to ceramics. Currently, there are about 10 students in these areas. These programs and research areas are connected through the Materials Research Organization formerly the Advanced Materials Technology Unit, an inter-disciplinary organization, which provides liaison with industry.

Advanced Ceramics Research Programs

Department of Physics

Professor M. Sayer is director of the Applied Solid State Group, an organization consisting of three research associates and scientists, two technicians and six graduate students.

He is also involved in the fabrication of electronic ceramics in thin film form using magnetron sputtering and chemical deposition techniques. Thin film device development is

based on surface acoustic wave and electro-optic materials; piezoelectric ceramics and the electrical properties of oxide, superconducting and fast ion ceramics.

The group is interested in the development of instrumentation for the ceramic industry. Specific R&D contracts include: thin film device development using piezoelectric materials; thermoelectric generator design; high T_c superconductors; piezoelectric ceramics; and electroluminescent displays; and polymer-ceramic composites.

Department of Materials and Metallurgical Engineering

Research areas include: the mechanical properties of ceramics; ceramic moulds for metallurgical applications; the processing of silicon carbide powders. V.D. Krstic is involved in: the processing of advanced ceramics and whisker reinforced composites; the mechanical properties of ceramics and brittle composites; and microstructure/materials properties. C.M. Hansson is concerned with materials degradation, particularly of concrete and other ceramics. Powder production and processing of ceramics using plasma methods is investigated by C.A. Pickles.

For Further Information:

Contact:

Dr. C.M. Hansson	613-545-6831
Dr. M. Sayer	613-545-2693
Dr. V.D. Krstic	613-545-2754
Dr. C. A. Pickles	613-545-2693

Materials Research Organization
613-545-2755

Queen's University
Kingston, Ontario
Canada K7L 3N6

ACADEMIC INSTITUTION

ROYAL MILITARY COLLEGE OF CANADA

Description

The Royal Military College of Canada provides undergraduate and graduate education in arts, science and engineering of officer cadets and commissioned officers in the Canadian Armed Forces. No formal degree in Ceramics is offered.

Research in advanced ceramic materials is being carried out in the Laboratory for Ferroic Materials and in the Laboratory for Superconducting Materials, both of which are in the Department of Physics.

Advanced Ceramics Research Programs

The Ferroic Materials Group comprises four professors (Drs. B. K. Mukherjee, H. D. Wiederick, N. Gauthier and A. Lachaine) and two research assistants.

Dr. Mukherjee and Dr. Wiederick have established a laboratory for the complete characterization of the dielectric, piezoelectric, electrostrictive and pyroelectric properties of ceramic materials. Their interests include:

- ▶ the basic physics of these materials;
- ▶ the development of advanced piezoelectric ceramics and ceramic-polymer composites for use in sonar, non-destructive testing (NDT) and medical transducers;
- ▶ the development of electrostrictive ceramics, ultrasonic actuators and motors;
- ▶ the development of smart devices using the piezoelectric and pyroelectric properties of materials.

Dr. Lachaine's interests include the application of photoacoustic methods to determine the thermal properties of ceramics.

Dr. Gauthier's interests are in obtaining a better theoretical understanding of ceramics and ceramic-polymer composites.

The Ceramic Superconductivity Group at RMC comprises two professors (Drs. E. Batalla and L. S. Wright) and two research associates. Their current interests include:

- ▶ the magneto-optic observation of magnetic field patterns in thin film YBCO and thallium compounds;
- ▶ the determination of magnetic shielding current densities from magneto-optic using a current loop finite model;
- ▶ the study of substrate defects that cause current density anomalies in thin films.

For Further Information:

Dr. B. K. Mukherjee	613-541-6348
Dr. H. D. Wiederick	613-541-6434
Dr. E. Batalla	613-541-6067
Dr. L. S. Wright	613-541-6340
Dr. A. Lachaine	613-541-6041
Dr. N. Gauthier	613-541-6332

Department of Physics
Royal Military College of Canada
Kingston, Ontario
Canada K7K 5L0

FAX: 613-542-9489

ACADEMIC INSTITUTION

TECHNICAL UNIVERSITY OF NOVA SCOTIA

Description

The Technical University of Nova Scotia (TUNS) provides education in engineering, architecture and computer science. The total undergraduate and graduate student enrollments are 1000 and 250, respectively.

The Department of Engineering Physics and Metallurgical Engineering offer undergraduate and graduate instruction in advanced ceramics. However, there is no formal degree program in ceramic engineering. The graduate programs in the Faculty of Engineering lead to MEng, MASc and PhD degrees, and students may choose ceramics as an area of research for specialization.

Advanced Ceramics Research Programs

The Advanced Ceramics Group at TUNS comprises two professors (Drs. H. W. King and J. G. Murphy), one Adjunct Professor (Dr. D. W. Jones, Faculty of Dentistry, Dalhousie University), one technician and five graduate students.

Professor King's interests include:

- ▶ spray and freeze-drying of precursor powders for ceramic conductors and superconductors;
- ▶ ceramic conductors and superconductors;
- ▶ crystal structures and phase diagrams of rare earth/transition metal oxide ceramics;
- ▶ physical property determination at ambient and elevated temperatures.

Specific areas in which government and industry-supported R&D contracts exist are electrically conducting ceramics, electro-catalysts (for oxygen evaluation) and

superconducting ceramics.

Professor Murphy's interests include:

- ▶ mechanical properties of bulk ceramics and plasma-sprayed ceramic coatings;
- ▶ electrical and electrochemical properties of perovskite oxides and plasma-sprayed coating of these oxides;
- ▶ finite element analysis of ceramic and ceramic composite components and corresponding mechanical testing;
- ▶ fabrication of composite electroceramics using extruded and pultruded organic materials.

Specific areas in which government and industry-funded R&D contracts exist are plasma-sprayed coatings on organic component substrates; finite element (FE) analysis and mechanical testing of ceramic valve components; plasma-sprayed coatings on Ti for aerospace use; and pultrusion of advanced organic composite systems.

For Further Information:

Dr. H. W. King 902-429-8300
Ext. 2205

Dr. J. G. Murphy 902-429-8300
Ext. 2207

Dr. D. W. Jones 902-424-2545

Department of Metallurgical Engineering
Technical University of Nova Scotia
P.O. Box 1000
Halifax, Nova Scotia
Canada B3J 2X4

FAX: 902-429-8300 EMRL#2207

ACADEMIC INSTITUTION

UNIVERSITY OF BRITISH COLUMBIA

Description

The University of British Columbia offers instruction through 12 faculties and 10 schools, covering agricultural sciences, arts, applied science (engineering), Asian studies, commerce and business administration, community and regional planning, dentistry, education, forestry, library, medicine, music, nursing, pharmaceutical science and law. The enrollment is approximately 23,000 undergraduates and 4000 graduate students. Another 6000 enroll during summer months as part-time students.

The Department of Metals and Materials Engineering, one of the nine departments in the Faculty of Applied Science, offers both undergraduate and graduate programs in Metallurgy and Materials Engineering (which includes both ceramics and polymers) leading to B.A.Sc., M.A.Sc. and Ph.D. degrees. There are between 60 and 70 undergraduates in these programs and about 45 graduate students.

Advanced Ceramics Research Programs

The complement of 12 personnel currently working in the field of ceramics at UBC comprises Professors A.C.D. Chaklader, J.K. Brimacombe, I.V. Samarasekera, and S.S. Cockcroft supported by research engineers, post-doctoral fellows and graduate students.

The following is a list of active research programs in the department:

- ▶ reactive sintering and reactive hot pressing of advanced ceramic composites (Dr. A.C.D. Chaklader);
- ▶ composition and stoichiometric effect on superconducting ceramics; and fabrication of wires, thin and thick film superconductors (Dr. A.C.D. Chaklader and Dr. J.A. Lund);
- ▶ composite (porosity-gradient) and slag resistant refractories (Dr. A.C.D. Chaklader);
- ▶ plasma synthesis and characterization of advanced ceramic powders (Dr. A.C.D. Chaklader);
- ▶ synthesis of ceramic composite powders, (Dr. A.C.D. Chaklader);
- ▶ thermal stress in ceramics; mathematical modelling of fused cast refractories (Dr. A.C.D. Chaklader, Dr. J.K. Brimacombe, Dr. I.V. Samarasekera and S.S. Cockcroft);

The research programs receive financial support from federal government agencies (NSERC, NRC); the Science Council of B.C.; and industrial companies (Clayburn Refractories Ltd., Cominco Ltd., B.M. Hi-Tech Ltd. and Standard Oil Engineered Materials of the U.S.).

Services:

Development of body compositions for both standard and advanced ceramics. Computer modelling of fluid flow and stress field during solidification.

Handling refractories problems such as slag attack, cracking etc.; sintering and hot-pressing; testing of raw materials by X-ray, SEM, EM etc.

For Further Information:

Contact:

Dr. A.C.D. Chaklader (604) 228-2705

Dr. J.A. Lund (604) 228-2676

Department of Metals and Materials Engineering

University of British Columbia

309-6350 Stores Road

Vancouver, B.C.

Canada V6T 1W5

FAX: 604-228-7006

ACADEMIC INSTITUTION

UNIVERSITY OF SHERBROOKE

Description

The University of Sherbrooke provides undergraduate and graduate instruction in arts, business, engineering, humanities, medicine and sciences. The total undergraduate and graduate enrollments are 9108 and 1253, respectively.

The Faculty of Engineering offers BEng, MASc and PhD degrees in chemical, civil, electrical and mechanical engineering. In these areas there are 1146 undergraduates and 116 graduates. Activities in materials engineering are found in the chemical, civil and mechanical engineering departments. There are about 20 graduate students specializing in concrete, rocks, material processes, ceramics and composites.

Advanced Ceramics Research Programs

The activities in advanced materials and ceramics are expanding in the fields of composite research and development and in thermal plasma technology. There are 25 people involved: five professors (Drs. C. Roy, M. Boulos, D. Gravelle, D. Proulx, P. Proulx); three research associates; two technicians; and 15 graduate students.

The research programs are:

- ▶ damage tolerance in glass and carbon-reinforced metallic and plastic matrices;
- ▶ plasma-spray coating of metallic substrates with alloys and ceramics;
- ▶ damage monitoring in materials by advanced acoustic emission techniques;
- ▶ plasma preparation of ultrafine powders of metals, alloys and ceramics by rapid

solidification techniques;

- ▶ synthesis of ultrafine SiC powder using a d.c. plasma jet reactor;
- ▶ plasma sintering of ceramics;
- ▶ diagnostics and mathematical modelling of particles and plasma flows, melting and evaporation under plasma conditions.

Specific R&D contracts supported by government and industries include:

- ▶ development of a process for the synthesis of ultrafine powder of SiC and its characterization;
- ▶ induction plasma preparation of ultra-fine Si₃N₄ powder;
- ▶ fabrication of amorphous coatings on steel substrate by d.c. plasma spraying;
- ▶ development of an acoustic emission system for monitoring real-time damage growth in composites.

For Further Information:

Contact:

Dr. Maher Boulos 819-821-7168
Dr. Clermont Roy 819-821-7155 or 7144
Faculty of Engineering
University of Sherbrooke
2500 University Boulevard
Sherbrooke, Quebec
Canada J1K 2R1
PHONE: 819-821-7000
FAX: 819-564-5643
TELEX: 05-836149 BIBUNIVSHB

ACADEMIC INSTITUTION

UNIVERSITY OF TORONTO

Description

The University of Toronto, which was granted its charter in 1827, is the largest university in Canada, with well over 50,000 students on three campuses. The university offers a full range of undergraduate and graduate programs, and places a strong emphasis on research. The school of Graduate Studies comprises over 80 departments, centres and institutes offering programs in four divisions: Humanities, Social Sciences, Physical Sciences and Life Sciences.

The University of Toronto does not offer a formal degree program in ceramics. At the undergraduate level, ceramic materials may be studied in the metallurgical engineering and materials science program which leads to a BASc degree. This program has two formal options in its two senior years: the metallurgical option and the materials option which offers detailed study of ceramic, metallic, polymeric and composite materials. Ceramics may also be studied in a material science program 'leading to a BSc degree' offered by the Department of Chemistry and Metallurgy and Materials Science.

Graduate research in materials is centered in the Department of Metallurgy and Materials Science, although several other departments and institutes at the university are involved with work in this field, particularly the Department of Chemical Engineering Research in ceramics is conducted in the Departments of Metallurgy and Materials Science and Chemical Engineering. Several projects are conducted in cooperation with other departments and institutes at the university, the Ontario Centre for Materials Research and other universities. The graduate programs lead to MEng, MASc and PhD degrees.

Advanced Ceramics Research Programs

Research programs in the following areas are being conducted at the university.

- ▶ Powder Processing and Forming of Advanced Ceramics (Prof. T. W. Coyle)
- ▶ Fracture Behavior and Toughening Mechanisms in Ceramics (Prof. T. W. Coyle)
- ▶ Ceramic Matrix Composites (Prof. S. DasGupta)
- ▶ Bioceramic Coatings (Prof. R. Pilliar)
- ▶ High Temperature Ceramic Phase Equilibria (Prof. D. Barham and Prof. H.N. Tran)
- ▶ High Tc Superconductors (Prof. J.W. Rutter)
- ▶ Plasma Processing of Ceramics (Prof. J.M. Toguri)
- ▶ Properties of Compound Semiconductors (Prof. H. Ruda)
- ▶ Ceramic Particulate Reinforced Metal Composites (Prof. Z. Wang)
- ▶ High Strength Fiber Composites (Prof. M.R. Piggott and Prof. M.T. Kortschot)

For Further Information:

Contact:

Dr. T. W. Coyle

Department of Metallurgy and Materials Science
University of Toronto

184 College Street

Toronto, Ontario

Canada M5S 1A4

PHONE: 416-978-5647

FAX: 416-978-4155

TELEX: 06-218915 UTENTOR

ACADEMIC INSTITUTION

UNIVERSITY OF WATERLOO

Description

The University of Waterloo provides undergraduate and graduate instruction in sciences, engineering, mathematics, human kinetics and leisure studies, environmental studies, arts and humanities. The total undergraduate and graduate student strengths of the university are 22,674 and 1,758, respectively.

Studies of ceramics and related subjects are in three graduate areas in the faculties of Engineering and of Science.

Advanced Ceramics Research Programs

In the Department of Physics, four faculty members are studying high-temperature ceramic superconductors, both in bulk and thin film form.

One researcher and her students are working in ceramics in the Department of Chemistry, and two faculty members and their students are working on projects involving ceramics in the Department of Engineering.

The individual research interests include:

Dr. D. E. Brodie (Physics), with one research associate and one graduate student are studying vacuum-deposited and sputtered layers of high-temperature ceramic superconductors primarily involving Y-Ba-Cu-O but also other elemental combinations. These are characterized using Auger analysis, transmission electron microscopy, as well as magnetic and electrical properties.

Drs. F. E. Boswell, J. Corbett and H. J. T. Smith (Physics) and their graduate students are preparing and studying bulk samples of high-temperature ceramic superconductors. The characterizing experiments include electron microscopy, X-ray analysis, magnetic and electrical properties.

Dr. L. F. Nazar (Chemistry) is developing new low-temperature routes for the synthesis of microporous metal oxide materials. These processes are expected to give metastable solid state compounds which cannot be synthesized by the traditional high-temperature methods. The structures and properties of the materials are also being investigated.

Dr. Weckman (Mech. Eng.) and his students are studying alumina-reinforced metal-matrix composites.

For Further Information:

Department of Physics:

Dr. D. E. Brodie	519-888-4465
Dr. F. E. Boswell	519-885-1211, Ext. 2219
Dr. J. Corbett	519-885-1211, Ext. 3201
Dr. H. J. T. Smith	519-885-1211, Ext. 2431

Department of Chemistry:

Dr. L. F. Nazar	519-885-1211, Ext. 4637
-----------------	-------------------------

Department of Mechanical Engineering

Dr. D. Weckman	519-885-1211, Ext. 2861
----------------	-------------------------

Department of Mechanical Engineering

University of Waterloo

Waterloo, Ontario

Canada N2L 3G1

TELEX: 069-55259

ACADEMIC INSTITUTION

UNIVERSITY OF WINDSOR

Description

The University of Windsor evolved in 1963 from Assumption College which opened its doors in 1857. The University maintains nine faculties: Arts, Law, Social Science, Science, Engineering, Human Kinetics, Business Administration, Education, and Graduate Studies and Research. The present undergraduate enrollment is 8500 full-time and 4200 part-time students. The graduate enrollment is 568 full-time and 179 part-time students.

Although the university does not offer a formal ceramics degree, ceramic-related courses are taught to all undergraduate students in the Faculty of Engineering. The degrees offered are BASc, MASc and PhD.

The Department of Engineering Materials, within the Faculty of Engineering, offers additional ceramic-related courses at the undergraduate level. The department has 10 graduate and 11 undergraduate students.

Advanced Ceramics Research Programs

Professor H. Yamauchi and Professor D. F. Watt, both of the Department of Engineering Materials, are involved in advanced ceramics research.

Professor Yamauchi and his group of seven researchers are working on the following programs.

- ▶ piezoelectric thin films based on Ba-Si-TiO;
- ▶ superconducting ceramics based on Ba-Y-Cu-O;
- ▶ superconducting thin films based on Ba-Y-Cu-O;

▶ TiN thin films

Professor Watt and his group of five researchers are working on fracture toughness and development of toughness test procedures.

For Further Information:

Contact:

Dr. H. Yamauchi 519-253-4232
Ext. 2602

Dr. D. F. Watt 519-253-4232
Ext. 2600

Department of Engineering Materials
University of Windsor
401 Sunset Avenue
Windsor, Ontario
Canada N9B 3P4

ACADEMIC INSTITUTION

FEDERAL GOVERNMENT ORGANISATIONS

AECL RESEARCH

Description

AECL Research is the research company of AECL, established in 1952, a Federal Crown Corporation with a mandate to develop peaceful uses of nuclear energy for the benefit of Canada. AECL is probably best known throughout the world for the CANDU reactor, as well as for its cancer therapy equipment and radioisotopes. AECL Research has over 35 years of experience in nuclear and technical ceramics, with an excellent mix of ceramic skills and facilities. The current emphasis in ceramic research is on the development of nuclear ceramics for both fission and fusion application and of advanced oxide ceramics for non-nuclear applications.

Specialization

At its research laboratories in Chalk River, Ontario and Pinawa, Manitoba, AECL Research specializes in oxide ceramics, glasses and glass ceramics. Two key areas of concentration are:

- 1) Ceramic process development
 - .powder/colloid preparation;
 - .grinding and granulation;
 - .sol-gel processing;
 - .forming and firing;
 - .materials evaluation.
- 2) Non-destructive testing (NDT)
 - .computed tomography;
 - .neutron diffraction & radiography.

In recent years, AECL has begun to apply its skills to non-oxide ceramics.

Products and Services

- chemical and thermal analysis;
- powder and colloid characterization;
- mechanical testing;
- microstructure evaluation;

►non-destructive testing.

Research and Development services are provided on a contract basis in the areas of ceramic processing, product development and NDT. AECL's specialized products include thoria products and NDT instrumentation.

Advanced Ceramic Activities

Ceramic research at AECL Research is done by the Advanced Ceramics Group of the Fuel Materials Branch. The group has eight laboratories where the following processes are done: chemical synthesis, milling, mixing, spray drying, extrusion, tape casting, pressing, slip casting, fibre forming, sintering, annealing, powder characterization, polishing and microstructural examination. There is also a dedicated laboratory used for making thoria parts. Also available at AECL Research are the services and specialization offered by other research groups such as neutron diffraction, neutron radiography, computed tomography and chemistry.

International Experience

Through its various Research and Development and Marketing activities, AECL Research maintains close ties abroad and has offices in many countries. Its programs on nuclear ceramics interact strongly with similar programs in Europe, Japan and the United States.

For Further Information:

Contact:

Dr. Jim Sullivan
Group Leader Advanced Ceramics
AECL Research
Chalk River Laboratories
Chalk River, Ontario
Canada KOJ 1J0
PHONE: 613-584-3311
FAX: 613-584-4525

FEDERAL GOVERNMENT ORGANIZATION - NUCLEAR CERAMICS RESEARCH & DEVELOPMENT

CAMECO CORPORATION

Description

CAMECO Corporation is owned by the Government of Saskatchewan and the Government of Canada. The Corporation was established in 1932 and employs 300 people.

Specialization

At Port Hope, CAMECO produces three major products which are:

- 1) UF₆ (intermediate product to fuel - light water reactors);
- 2) UO₂ (product used for CANDU Canadian reactors);
- 3) depleted uranium metals for counter weights and shieldings.

Research and Development is done within the organization and other divisions of the corporation have established joint efforts with Canadian Foreign Companies.

International Experience

They export over 80% of their products.

For Further Information:

Contact:

President/CEO:

Robert Tanaka
CAMECO Corporation
1 Eldorado Place
Port Hope, Ontario
Canada L1A 3A1

PHONE: 416-885-4511
FAX: 416-885-9124

CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY

Description

Canada Centre for Mineral and Energy Technology (CANMET) is the research and development branch of the Department of Energy, Mines and Resources of the Government of Canada. The Main objectives of the centre are to:

- ▶ support the development and implementation of departmental and general governmental policies;
- ▶ protect health and safety in the workplace and environment and formulate criteria for their standards and regulation;
- ▶ promote industrial productivity and economic and regional development.

The branch is subdivided into three sectors: Energy Technology, Minerals Technology, and Policy, Planning and Services. Under the Minerals Technology sector, the mineral sciences laboratories are engaged in minerals-oriented Research & Development; the ceramics section is a part of this organization.

Specialization

The Research & Development programs of the ceramics section of CANMET are generic in nature, aimed towards the development of both traditional and advanced ceramic compositions, process technology and evaluation of properties. They can be grouped as follows:

- ▶ electrical ceramics: piezoelectrics, ferro-electrics, dielectrics and solid electrolytes;
- ▶ composites: toughened and reinforced oxide and non-oxide ceramics;
- ▶ refractory materials: evaluation of performance, microstructure and mechanical properties;

- ▶ ceramic powders: synthesis of oxide and non-oxide systems using thermal, hydrothermal, sol-gel, metal-organic, spray-drying and freeze-drying processes;
- ▶ Statistical Design, Design of Experiments, Quality Engineering for improved yield, performance and efficiency in Research & Development through to Production.

Ceramic Section Activities

CANMET's ceramic section is one of the oldest ceramics Research & Development laboratories in Canada. Established in the 1920s, it was a pioneer in the development of magnetic ceramics, such as barium hexaferrites, and piezoelectric ceramics, such as lead zirconate titanates. Presently, the unit consists of eight scientists and four technologists.

One of the important features of the section is its close involvement with industry and universities. In the past, the section has been extensively involved with the technical aspects of a number of industrial programs funded by other federal agencies such as National Research Council, Departments of National Defence and Regional Industrial Expansion, Communications and Consumer and Corporate Affairs. In future, the sector will continue its interaction with the existing and new advanced ceramics companies in Canada.

For Further Information:

Dr. T. A. Wheat
CANMET, Depart. of Energy, Mines & Res.
405 Rochester Street
Ottawa, Ontario
Canada K1A 0G1
PHONE: 613-992-1395
FAX: 613-992-9389

FEDERAL GOVERNMENT ORGANIZATION - CERAMICS RESEARCH & DEVELOPMENT

DEPARTMENT OF NATIONAL DEFENSE

Description

The in-house Research & Development activities of the Department of National Defence are the responsibility of the Defence Research Establishments across Canada. The material-related projects are carried out mainly at the Defence Research Establishment Atlantic in Dartmouth, N.S., the Defence Research Establishment Pacific in Victoria, B.C. and the Defence Research Establishment in Valcartier, Quebec.

Specialization

DND does a limited amount of research and development on ceramic materials in their research establishments but the bulk of the department's needs are met by Research & Development services provided by Canadian industry, universities and provincial research organizations on a contract basis.

Advanced Ceramics Research Programs

- ▶ Evaluation of Ceramic Coatings for Gas Turbine Blades and Vanes: this project is sponsored by the Director General of Research and Development - Operations. The actual work is carried out by a Canadian company on a contract basis, but a department representative monitors and coordinates the program.
- ▶ The Defence Research Establishment Atlantic/Dockyard Laboratory in Dartmouth, N.S., is active in the development of advanced ceramics (coatings and monolithic ceramics) for fire safety applications. Fire-resistant coatings are being developed by an outside contractor on behalf of DREA. Inorganic intumescent coatings are now

being evaluated for both commercial and defence applications. Project supervision and some technical support is provided by the scientific staff of DREA. A second program concerns the development of fire-retardant boron nitrite reinforced/filled thermal plastic composites for electrical cable sheathing applications. The R&D is being done by a Canadian company with technical support from scientists at DREA.

- ▶ Defence Research Establishment Atlantic (DREA) also supports research and development on piezoelectric ceramic materials for hydrophone applications at the Royal Military College at Kingston, Ontario.
- ▶ The Defence Research Establishment Pacific (DREP) has initiated basic studies on advanced structural ceramics using nuclear magnetic resonance techniques. These studies are directed at determining how the atomic structure of ceramic materials translates into physical properties. In addition, DREP is sponsoring the development of advanced ceramic transducers at McMaster University and Research in Functional Ceramics at UBC.

For Further Information:

Chief, Defence Research Establishment Atlantic
Department of National Defence
P.O. Box 1012
Dartmouth, N.S.
Canada B2Y 3Z7
PHONE: 902-426-3100
Chief, Defence Research Establishment Pacific
Department of National Defence
Esquimalt, B.C.
Canada VOS 1B0
PHONE: 604-363-2888
FAX: 604-363-2856

FEDERAL GOVERNMENT ORGANIZATION - RESEARCH & DEVELOPMENT AND
STRUCTURAL CERAMICS

NATIONAL RESEARCH COUNCIL OF CANADA

Description

The National Research Council of Canada was established by the Canadian government in 1916 to coordinate and promote scientific and industrial research in Canada. The National Research Council, Canada's leading research and development agency, provides a comprehensive network of service, facilities, technology transfer programs, and collaborative research opportunities in support of Canadian science and industry. Drawing on the scientific and technical expertise of its multidisciplinary institutes and financial and technical support for industry through its Industrial Research Assistance Program (IRAP) across the country, NRC helps Canadian firms develop international competitiveness.

Research and Development activities are carried out in different Institutes. Development of coatings and of bulk ceramics as well as their non-destructive evaluation are carried out mainly by the Industrial Materials Institute (Boucherville, Quebec). Development and electronic evaluation of thin films are pursued at the Science Affairs Office (Ottawa) and physical characterization of materials is conducted in the Institute for Microstructural Science. Evaluation of advanced ceramics for aeronautic applications is performed at the Institute for Aerospace Research (Ottawa) and tribological aspects at the Institute for Mechanical Engineering (Vancouver).

Advanced Ceramic Activities

A part of the ceramics program is devoted to the improvement of deposition technologies for producing coatings and enhancing their performance in severe environments. Processing of high critical temperature

superconductors also constitutes a significant effort. The behavior of structural ceramics is being studied for the processing of liquid metals such as the production of steel by strip casting. Manufacturing technologies such as injection molding of ceramics are also under development. Performance evaluation, characterization of properties and inspection of ceramics are carried out by non-destructive methods.

Research Programs

- ▶ Coatings
- ▶ High Critical Temperature Superconductors
- ▶ Shaping and Applications of Advanced Ceramics
- ▶ Evaluation of Properties and Inspection

For Further Information:

Contact:

Dr. B. Champagne
Section Head, Metals and Ceramics
National Research Council of Canada
Industrial Materials Institute
75 De Mortagne Blvd.
Boucherville, Quebec
Canada J4B 6Y4

PHONE: 514-641-2280
FAX: 514-641-4627

FEDERAL GOVERNMENT ORGANIZATION - RESEARCH & DEVELOPMENT AND NDE
OF MATERIALS, CERAMIC COATINGS

PROVINCIAL R & D ORGANISATIONS

ALBERTA RESEARCH COUNCIL

Description

The Alberta Research Council is a crown corporation of the Province of Alberta, with 600 employees, offering a diversified range of scientific, engineering and technological research and testing capabilities in:

- ▶ Advanced Technologies
- ▶ Biotechnology
- ▶ Coal and Hydrocarbon Processing
- ▶ The Electronics Test Centre
- ▶ Forestry
- ▶ Geological Survey
- ▶ Materials and Testing
- ▶ Oil Sands and Hydrocarbon Recovery
- ▶ Resource Technologies
- ▶ Terrain Sciences
- ▶ Joint Research Venture Program
- ▶ Industrial Technology Advisor Network (ITAN)

Founded in 1921 the mission of the Alberta Research Council is to advance the economy of the province by promoting technology development, performing applied research, and providing expert advice, technical information and scientific infrastructure that is responsive to the needs of the private sector and supports activities in the public sector.

Specialization

The Alberta Research Council introduced a technology transfer program through joint research ventures. Now in its sixth year, the Joint Research Venture Program has helped or is helping, some two dozen companies, many of them in the high technology industry.

The Industrial Advisor Network, a collaborative program with the National Research Council, is an efficient and cost-effective economic instrument for industrial development; the industrial

technology advisors provide the bridge between technology sources and potential users.

Advanced Ceramic Activities

The Alberta Research Council provides specific services in:

- ▶ Ceramic Coatings
- ▶ Wear resistant bulk ceramics
- ▶ Consulting in Ceramics Research & Development.

They also provide processes and specialization in low pressure, inert gas plasma spray.

International Experience

The Alberta Research Council has a large number of International links through Members of Universities, technology transfer agreements, contracts, consortia etc. As a stimulus in the Pacific Rim, the Alberta Research Council now has a representative attached to the Government of Alberta Tokyo offices. In addition, ARC has a number of visiting scientists from abroad working in its laboratories.

For Further Information:

President/CEO: Mr. Clem W. Bowman
Contact:

Dr. Robert Heimann
Manager, Materials Section
Manufacturing Technologies Department
Alberta Research Council
P.O. Box 8330, Station F
Edmonton, Alberta
Canada T6H 5X2
TEL: 403-450-5403
FAX: 403-450-5477
TELEX: 037-2147

PROVINCIAL R&D ORGANIZATION - CERAMICS RESEARCH & DEVELOPMENT;
COATINGS

MANITOBA RESEARCH COUNCIL

Description

The Manitoba Research Council is a product development and testing organization serving Manitoba industry. The MRC has become involved in a wide range of projects and is accredited by the Standards Council of Canada for specific tests registered with the council.

The objectives of MRC are:

- ▶ to provide scientific and technical services to industrial and government clients;
- ▶ to stimulate the application of new technology in industry;
- ▶ to aid in translating technology into manufacturing opportunities;
- ▶ to assist industry in monitoring and testing its products and workplaces.

MRC provides industrial clients with consulting, and product development and testing services on a contractual basis and a wide range of technical information and advisory services.

Specialization

MRC provides specialized services in:

- ▶ electrical/electronics engineering;
- ▶ mechanical/manufacturing engineering;
- ▶ computer-aided engineering;
- ▶ materials engineering;
- ▶ chemical technology
- ▶ biotechnology.

MRC provides assistance to industry in the development and use of ceramics as a part of its material engineering program.

Services

Specific services provided by MRC are:

- ▶ electronic circuit design, computer-based systems design, communication

system design, product selection, testing and evaluation;

- ▶ mechanical design and analysis (solid modelling, finite element (FE) analysis, model analysis, fatigue and system dynamics);
- ▶ product/process evaluation, prototype/product fabrication, material selection and process development;
- ▶ advanced industrial materials and processes;
- ▶ chemical and microbiological analysis of hazardous waste, air quality monitoring and environmental containments.

Advanced Ceramic Activities

MRC provides specific assistance in the evaluation, selection and use of coatings, specifically in the following areas:

- ▶ plasma coating for wear/abrasion applications;
- ▶ electrochemical techniques for depositing ceramic/metal coatings.

International Experience

MRC has numerous international projects to its credit. Activities have concentrated mainly in the U.S. and Pakistan in product design, product analysis and technology transfer.

For Further Information:

President/CEO: Dr. Erling Nyborg

Contact:

Mr. L. Barker, VP Operations

Manitoba Research Council

1329 Niakwa Road East

Winnipeg, Manitoba

Canada R2J 3T4

PHONE: 204-945-6000

FAX: 204-945-1784

PROVINCIAL R&D ORGANIZATION - MATERIALS SELECTION AND PROCESS;
PLASMA COATING

NOVA SCOTIA RESEARCH FOUNDATION CORPORATION

Description

Nova Scotia Research Foundation Corporation was established in 1946 by the Province of Nova Scotia to use science and technology to assist in the economic development of Nova Scotia. A staff of 115 scientists, engineers, technicians and support staff occupy a well equipped 5,670 m² laboratory building, a 560 m² pilot plant, and a 445 m² environmental test centre on the Corporation's four-hectare Dartmouth site.

Specialization

The Corporation pursues two main goals assistance to industry in the solution of today's technical problems, and product/process innovation in anticipation of tomorrow's opportunities. While the Corporation serves all sectors of Nova Scotia's industrial economy, it emphasizes technological support for secondary manufacturing industry and takes a special interest in developing Nova Scotia's industry potential.

Three operating divisions 1) Applied Science, 2) Industry Services and 3) Product Development - carry out technical assignments for 650 companies and government departments each year.

Applied Science:

Assists industry and government with applied Research & Development and scientific services related to Nova Scotia's natural resources.

Industry Services:

Provides technical assistance to small and medium sized manufacturers to improve productivity and technological capabilities.

Product Development:

Specializes in engineering, manufacturing, and marketing to develop Nova Scotia products for international markets.

Advanced Ceramic Activities

Ceramic research and development work at NSRF was initiated in 1981 in cooperation with the Atlantic Research Laboratory of the National Research Council. Work has concentrated on the development and evaluation of erosion-resistant ceramics based on alumina. To facilitate these studies, the foundation has designed and built a special fluidized-bed feeder for eroding ceramic specimens with silicon carbide powders. The foundation has successfully developed composition and process technologies for the fabrication of dense alumina parts, and erosion-resistant inserts for use in nozzles for burning coal-water slurries have been manufactured and sold.

International Experience

NSRF, through Nova Magnetics Limited exports magnetic drivers for the ocean industry and chemical process industry throughout the world.

For Further Information:

Contact:

Mr. R.F. MacNeill, Vice President
Nova Scotia Research Foundation
P.O. Box 790
Dartmouth, Nova Scotia
Canada B2Y 3Z7
PHONE: 902-424-8670
FAX: 902-424-4679
TELEX: 019-22719

PROVINCIAL R&D ORGANIZATION

ONTARIO CENTRE FOR MATERIALS RESEARCH

Description

The Ontario Centre for Materials Research (OCMR) is one of the seven Centres of Excellence set up by the Ontario provincial government in January 1988. With enabling funds from the provincial government, the Centre has been created to perform world-class university research in materials in Canada. In this innovative venture, OCMR shares the expertise and resources of universities with industry by engaging in collaborative research programs.

OCMR's objectives are:

- ▶ to provide a multi-disciplinary environment in which world-quality long-term materials research will be undertaken in areas of strategic importance for Ontario's industries;
- ▶ to encourage close, interactive relationships between the academic community and their industrial colleagues at all stages of product and process research and development;
- ▶ to educate and train personnel in areas of direct value to the material industries of Ontario.

Management and Membership

OCMR is a federally incorporated body, managed by a 16 member Board of Directors representing industry and the university community. The present university membership comprises: McMaster University, Hamilton; Queen's University, Kingston; University of Toronto; University of Waterloo; and University of Western Ontario, London. Almost all the research programs sponsored by OCMR are carried out in these institutions. Industrial support for OCMR comes from 47 companies. Detailed management structure, fees, classes of membership and program details are available. The annual research budget is approximately \$8

million.

Advanced Ceramic Activities

The Centre's research projects have been organized into five themes, each one involving researchers from more than one university. These are:

- biomaterials
- metals & ceramics
- polymers & composites
- optoelectronic materials
- interface science & technology

Ceramic materials research pertains in all five areas; however, specific programs on ceramics, development of new crystalline materials, new alloys and metal-matrix-composites, joining of materials and new methods of material synthesis will be performed under the metals and ceramics theme.

As part of the program in ceramics, OCMR has created a ceramics laboratory at McMaster University which contains the following equipment:

- .Hot Isostatic Press
- .HIP Dilatometer Furnace
- .Hot Press
- .Powder Characterization Equipment
- .Powder Processing Equipment
- .NDE by High Frequency Ultrasound

In addition, conventional mechanical testing and electronoptic techniques are available in associated laboratories. OCMR supplements the provincial government grant with contractual research projects with industry. Information dissemination is achieved through workshops, seminars and advanced educational courses.

For Further Information:

Dr. J.P. McGeer, Managing Director, OCMR
P.O. Box 1146, Kingston, Ontario
Canada K7L 4Y5
PHONE: 613-545-6490
FAX: 613-545-6510

PROVINCIAL R&D ORGANIZATION - PRECOMPETITIVE RESEARCH IN MATERIALS

ONTARIO LASER & LIGHTWAVE RESEARCH CENTRE

Description

The Ontario Laser & Lightwave Research Centre (OLLRC) is one of seven Centres of Excellence established by the Ontario Premier's Council in January 1, 1988. Its mandate is to:

- ▶ stimulate long-term advanced research
- ▶ foster and enhance laser and lightwave research and applications
- ▶ train and develop world-class researchers
- ▶ encourage the transfer and diffusion of technology to industry

so that Ontario is better able to compete in world markets into the twenty-first century.

The 400 square metre Facility is located in the McLennan Physical Laboratories on the downtown campus of the University of Toronto, in space rented from the University. The Centre employs 10 people.

Research Program

The OLLRC has mounted a highly specialized and innovative program of advanced research and applications in five theme areas:

- ▶ Novel Lasers and Light Sources
- ▶ Laser Spectroscopy: Frontiers of Molecular Dynamics and Surface Photochemistry
- ▶ Lightwave Science and Engineering
- ▶ Ultra-Fast Nonlinear Optics & Optoelectronics
- ▶ Lasers in Medicine

This program brings together 13 senior scientists, known as Principal Investigators, from five Departments of the University of Toronto and one from the Ontario Cancer Treatment Centre and McMaster University. Also collaborating in this research program are 13 Associates from five Ontario Universities.

The work of these scientists is conducted in close cooperation with 35 visiting scientists and postdoctoral fellows from various countries and approximately 90 graduate students. Research is being carried out mainly in their own laboratories, provided by the Universities and Institutes, and from time to time in the Facility. The collaborative nature of this research contributes significantly to the training and development of scientists and engineers in Ontario.

Educational Programs

The results of the research are disseminated through talks given at scientific conferences and papers published in refereed journals. The OLLRC, however, has attempted to reach beyond the scientific and academic communities and has organized educational programs designed to meet various levels of scientific understanding.

Equipment

Modern equipment (spanning the spectral range from the infrared to the ultraviolet) available for in-house or off-site use, includes a large variety of lasers, diagnostic and optical accessories, spectroscopic systems, and a full range of instruments for conducting fibre optics experiments.

For Further Information:

President/CEO: Dr. Boris P. Stoicheff

Contact:

Isobel McKone

Ontario Laser & Lightwave Research Centre
60 St. George Street, Suite 331
Toronto, Ontario
Canada M5S 1A7

PHONE: 416-978-3923

FAX: 416-978-3936

INDUSTRIAL ASSOCIATIONS

CANADIAN ADVANCED INDUSTRIAL MATERIALS FORUM (CAIMAF)

Description

CAIMAF's membership culture is a unique network of multi-disciplined organizations comprising advanced industrial materials (AIM) interests and knowledge holders in all the AIM technologies.

CAIMAF is a clearing house and forum for industry management seeking perspectives on broad issues that help stimulate competitive developments and use of AIM; and includes the transfer facilitation and commercialization of these related technologies on behalf of members.

Specialization

CAIMAF's mission is to stimulate and reinforce the competitive development and use of advanced industrial materials technologies in Canadian products and processes.

- ▶ To provide industry with a national hub for accessing and networking information in advanced materials and their processing technologies.
- ▶ To promote the required linkages between users, producers and knowledge holders of AIM developments into global markets.
- ▶ To help Canadian industrial excellence through the application of advanced materials and resulting systems.

Activities

CAIMAF is a non-profit association devoted to the following core activities:

- ▶ Networking and advisory facilitation
- ▶ Major quarterly conferences and seminars for management
- ▶ "The Gateway" Newsletter with AIM content for business managers
- ▶ Member directory and AIM technology sourcing
- ▶ International link-ups
- ▶ Representation roles for industry and government
- ▶ Networking information and consulting services to members
- ▶ Educational proponents for AIM curriculums.

Membership

Memberships are solicited from industry, government agencies, universities, industrial associations, research organizations and other bodies whose activities support the objectives of the forum. Current membership is 110.

For Further Information:

Contact:

Mr. Richard E. Glinski
Executive Director
Canadian Advanced Industrial
Materials Forum
One Yonge Street, 14th Floor
Toronto, Ontario
Canada M5E 1J9

PHONE: 416-363-7261
FAX: 416-363-3779

INDUSTRIAL ASSOCIATION - ASSOCIATION FOR AIM NETWORKING

CANADIAN CERAMIC SOCIETY

Description

The Canadian Ceramic Society arose from the amalgamation in 1932 of the Canadian National Clay Products Association (formed in 1901) and the Canadian Enameller's Association (formed in 1930).

The objectives of the Canadian Ceramic Society are:

- ▶ to advance the ceramic arts and sciences, and to encourage study and research in the various branches of the ceramic field;
- ▶ to promote improvement of the methods of production and quality of products;
- ▶ to establish close and mutually helpful relations between companies and persons engaged in industry.

The society is managed by an elected President and elected Board of Directors representing each of its four divisions: Structural Clay and Refractories, Pottery and Whitewares; Glass; Electronics and Basic Science.

The society sponsors a general convention with a technical program comprising all the divisions.

Memberships and Fellowships

The Canadian Ceramic Society has three types of membership: corporate members; active members; and student members. The Fellows of the society are nominated by a select committee and approved by the Board of Directors.

Publications

The Journal of the Canadian Ceramic Society is published quarterly and consists of scientific and technical papers presented at the annual convention, as well as those submitted to the society for publication. The Journal is distributed free to society members.

Educational Courses

The society offers a three-year certificate course in Ceramic Technology. Intended to present a concise study of ceramics in related fields and dependent processes, the course is currently available by correspondence.

For Further Information:

President: Ms. Connie Barry

Contact:

F. Diane Gaunt
Administrator
Canadian Ceramic Society
2175 Sheppard Avenue East
Suite 110
Willowdale, Ontario
Canada M2J 1W8

PHONE: 416-491-2886
FAX: 416-491-1670

INDUSTRIAL ASSOCIATION - CERAMICS INDUSTRY

CANADIAN UNIVERSITY-INDUSTRY COUNCIL ON ADVANCED CERAMICS

Description

The Canadian University-Industry Council on Advanced Ceramics (CUICAC) was created in June, 1986 as a joint effort between Canadian universities and industry, under the stewardship of the federal government.

The objectives of CUICAC are:

- ▶ to promote, foster and focus university and industry activities in the field of advanced ceramics;
- ▶ to ensure and contribute to, the establishment of national goals for advanced ceramics which incorporate research and development, manufacturing and technology and market development;
- ▶ to promote a broader understanding of international activities in advanced ceramics in Canada;
- ▶ to promote the awareness of the Canadian achievements and activities in advanced ceramics;
- ▶ to increase public awareness of the strategic importance of advanced ceramics;
- ▶ to promote and organize pre-competitive research programs for the benefit of its members.

CUICAC is administered by an elected Board of Directors and an elected president.

Membership

CUICAC has three types of membership all of which are restricted to Canadian organizations - university membership, industrial membership and associate membership.

Workshops, Seminars and Publications

CUICAC organizes three workshops every year, one of them in conjunction with the annual general meeting usually held in June. The themes of the workshops include scientific, technological and manufacturing topics related to advanced ceramics, as well as market implications and user needs.

In addition to workshops, CUICAC holds special seminars on subjects of interest to members.

CUICAC publishes a bi-monthly newsletter entitled Advanced Ceramics Update and transactions of the CUICAC workshops, which are distributed free to members. However, they may be purchased by non-members from the CUICAC office.

International Activities

Establishing links with national and international ceramic organizations is one of the important aims of CUICAC. It has already signed a mutual cooperation agreement with the Japan Fine Ceramics Association.

For Further Information:
Contact:

Dr. Parvez Kumar
Executive Director
Canadian University-Industry
Council on Advanced Ceramics
280 Albert Street, Suite 904
Ottawa, Ontario
Canada K1P 5G8

PHONE: 613-230-0868
FAX: 613-230-9376

INDUSTRIAL ASSOCIATION - TO PROMOTE, FOSTER AND FOCUS
UNIVERSITY AND INDUSTRY ACTIVITIES IN THE FIELD OF ADVANCED
CERAMICS

APPENDIX

PROPERTIES & APPLICATIONS OF ADVANCED CERAMICS

TABLE I**SOME CURRENT AND FUTURE APPLICATIONS OF ADVANCED CERAMICS**

CURRENT APPLICATIONS	FUTURE APPLICATIONS
Automotive Water-pump seals Turbines Catalytic converters Electronic controls Turbochargers	New engine designs: Turbines Low heat rejection diesels Advanced rotary regenerator Fixed boundary recuperators
Pulp & Paper Suction-box covers Dryer foils Pump liners and seals Hydrocyclones Pulpstones	1-piece covers 1-piece foils Refiner plates 1-piece hydrocyclones 1-piece pulpstones
Oil Industry Flow control valves Blast sleeves Bearings	Flow control valves Liners Bearings and seals
Environmental Waste water treatment Exhaust gas treatment Incinerator liners	Effluent treatment Exhaust gas treatment Filters
Metals Processing High temperature processing Burners Cutting tools Molten metal filters	Plasma spraying Nozzles High speed cutting tools Laser processing
Aerospace Bearings Heat shields Rocket nozzles Composites	High temperature applns. High strength/weight ratios High temperature engines Electronics
Electronics Semiconductor packages Multi-layer capacitors Gas and pressure sensors Optical waveguides	Multi-layer integrated pkgs. Electro-optical packaging High Tc Superconductors Radiation hardened packages
Defence Armour Submarine shaft seals Nozzles/Turbines Bearings	Improved armour Aerospace applications Tank power trains Optical/Heat transfer applns.

TABLE II
PHYSICAL PROPERTIES OF SOME CERAMIC MATERIALS

Material	Density (Mgm ⁻³)	Thermal Expan. (10 ⁻⁶ K ⁻¹)	Conduct. (Wm ⁻¹ K ⁻¹)	Elastic Modulus (GNm ⁻²)
Clay-based:				
Steatites	2.6	8	6	80
Oxides:				
Alumina (pure)	3.9	5.9	33	380
Berylia	2.9	6	300	340
Titania	4	6	4	280
Zirconia	5.8	8.5	2	200
Non-oxides:				
Boron Nitride	2.1	2	20	100
Boron Carbide	2.5	3.3	27	450
Silicon Nitride	2.8	1.5	14	250
Silicon Carbide	3	2.8	200	380
Diamond	3.5	4.8	2000	960
Graphite	1.8	2	90	15
Glasses:				
Soda-lime	2.4	7.8	1.2	73
Pyrex	2.25	3	1.1	68

NOTE: The data listed in these Tables is extracted from the *Handbook of Properties of Technical and Engineering Ceramics - Part 1*, by R. Morrell of the National Physical Laboratory, UK. Published by HMSO.

TABLE III
CORROSION RESISTANCE

Material	Acid	Alkali	Oxidation	Reduction
Alumina	Good	Fair	Good	Good
Silica	Good*	Poor	-	Bad at high temperatures
Porcelains	Good	Poor	-	-
Glasses	Good*	Good (low T)	-	-
Zirconia	Poor	-	-	Good
Magnesia	Poor	Good	-	-
Berylia	Poor	Poor	-	-
Thoria	Poor	Good	-	-
Titania	Fair	Poor	-	Poor
Silicon Nitride	Good	Poor	V. Poor	Good
Silicon Carbide	Good	Poor	-	-
Boron Nitride	Poor	Fair	-	Good
Titanium Diboride	Good	Poor	-	-

* Except for Hydrofluoric acid

TABLE IV**TYPICAL PROPERTIES OF ABRASIVES**

Property	Abrasive		
	Diamond	Alumina	Silicon Carbide
Chemical Comp.	C	Al ₂ O ₃	SiC
Density (gr/cm ³)	3.52	3.92	3.21
Rel. Therm. Condy.	100-350	1	10
Coeff. Therm. Exp. ($\times 10^{-6}/^{\circ}\text{K}$)	4.8	5.9	2.8
Degradation Temp. ($^{\circ}\text{C}$)	800	1,750	1,500

TABLE V
RELATIVE HARDNESS

Material	Knoop Hardness Factor (kg/mm ²)
Diamond	6,000 - 6,500
Titanium Diboride	3,400
Boron Carbide	2,300 - 2,800
Silicon Nitride	2,200
Silicon Carbide	2,000 - 2,500
Sapphire (pure corundum)	1,800 - 2,000
SIALON	1,800
Alumina Ceramics	1,450 - 1,750
Tungsten Carbide	1,050 - 1,900
High Speed Steel	650 - 900
Quartz	710 - 790

TABLE VI

CERAMIC SENSOR MATERIALS

Application	Property	Ceramic Material
Temperature sensor	Neg.Temp.Coeff. Pos.Temp.Coeff.	NiO, Fe ₂ O ₃ Doped BaTiO ₃
Oxygen (gas)	Solid Electrolyte Semiconductor	ZrO ₂ TiO ₂ , SrTiO ₂
Pressure	Piezoelectric	Pb(Zr, Ti)O ₃
Radiation	Pyroelectric	PZT type
Gas	Varistor	ZnO
Humidity		ZnO-Cr ₂ O ₃ MgCr ₂ O ₄
Electronic	Varistor catalyst	BaTiO ₃

TABLE VII**APPLICATION OF CERAMICS IN MICRO-ELECTRONICS**

Technology	Application	Ceramic Material
Information processing	Substrates Dielectrics Masks	Al_2O_3 , BeO, SiC, AlN Si_3N_4 , SiO_2 Borosilicate glasses
Information storage	Disk Tape Head	Iron oxide, Ferrite Chrome oxide Ferrites, Glass, Al_2O_3 substrates
Information display	Dielectric Seal Face-plate	Lead-borosilic. glass Pb-Zn- " " " Soda-lime glass
Information printing	Ink-jet Electro-erosion	ZrO_2 containing glass Cermets composites
Information transfer	Fibre Optics	SiO_2 , $\text{B}_2\text{O}-\text{SiO}_2$

TABLE VIII

OTHER APPLICATIONS OF ADVANCED CERAMICS

Applications	Materials
High temperature applications in heat engines, gas turbines etc.	SiC, SiC with Si ₃ O ₄ SiC with Al ₂ O ₃
Heat exchangers	As above plus ZrO ₂ composites
Wearability	Ni/TiC, Diamond-like thin films, SiC-Al ₂ O ₃ , WC-Co
Coatings	Diamond film, Mullite, Alumina composites, SiC, BN, ZrO ₂ , TiC
Medical	Bio-ceramics (Hydroxy-apatite, Phosphate-based)
Magnetic	Soft and Hard Ferrites
Optical	Translucent Alumina/Mullite Yttrium/Thorium ceramics for laser applications.
Chemical	Sensors: Gas (ZnO, Fe ₂ O ₃) Humidity (MgCr ₂ O ₄) Organic catalysts Electrodes
Nuclear	Fuels (UO ₂ , UO ₂ -PuO ₂) Shielding (SiC, Al ₂ O ₃ , C) Cladding (SiC, C)
Environment (Filters)	Porous ceramics (SiC-20)

HD95957.C2A3
Atlantic Research Laborat
Advanced ceramics :
 directory of Canadian
AIHK 1991 c.2

DATE DUE - DATE DE RETOUR

[illegible]

ISTC 1551 (2/90)

INDUSTRY CANADA/INDUSTRIE CANADA



130301