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ADVANCED CERAMICS

Directory of Canadian Activities





Industry, Science and Technology Canada

Industrie, Sciences et Technologie Canada



National Research Council Canada Conseil national de recherches Canada

ADVANCED CERAMICS

Directory of Canadian Activities

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Atlantic Research Laboratory Advanced Ceramic Program National Research Council of Canada

Advanced Industrial Materials Directorate Resource Processing Industries Branch Industry, Science and Technology Canada

March 1989

(Également disponible en français)

PREFACE

Over the past few years, interest in advanced ceramics in Canada has gained considerable momentum. While new materials and products are being developed and manufactured in this country, more and more potential users are evaluating the advantages of incorporating advanced ceramics into their operations. To help co-ordinate development of the new technology, Industry, Science and Technology Canada (ISTC) and the National Research Council Canada (NRC) have prepared this directory which describes briefly the Canadian activities in advanced ceramics. It is hoped that such a directory will act as a catalyst in bringing developers, manufacturers and users of advanced ceramics together to collaborate in the development of this fledgling industry. It should also highlight for the traditional Canadian industry sector the benefits of using advanced ceramics, and will be very useful in promoting technical exchanges and attracting investments at the national and international levels.

The scope of this directory has been limited to Canadian companies and organizations that are active in the field of advanced ceramics. It includes universities, federal and provincial government laboratories and research centres but it does not include companies and organizations that are involved only in traditional ceramics, nor does it include those primarily involved in semiconductors. The reader will easily find his or her way in this directory by using the table of content which can serve as a company or organization index and/or consulting the activity and product indexes at the end of the document.

The information compiled here is based on data obtained in response to a questionnaire and personal or telephone discussions. Efforts were made to cover all activities taking place in Canada. If any organizations or activities have been omitted, we would be grateful if it could be brought to the attention of ISTC or NRC to ensure that the information is included in future editions of the directory. Please send any corrections or omissions to:

National Research Council Canada Advanced Ceramic Program Atlantic Research Laboratory 1411 Oxford Street Halifax, Nova Scotia Canada B3H 3Z1

Industry, Science and Technology Canada Resource Processing Industries Branch Advanced Industrial Materials Directorate 235 Queen Street Ottawa, Ontario Canada K1A 0H5

ISTC and NRC thank all those who assisted in the preparation of this directory.

OVERVIEW

Industrial Activities

The advanced ceramics industry in Canada, although relatively small, is active in the research, development and manufacture of new products. These activities span the four important areas of ceramic powders, functional ceramics, structural ceramics and coatings.

Manufacture of ceramic powders is a well-established commercial activity. Alumina powders for the ceramic industry, specialty iron oxides for the ferrite industry and hard metal carbides for the cutting tool industry have been produced for many decades. But now, new products are being developed by both the existing manufacturers and new companies entering the field. To the former category belong reactive aluminas, silicon nitride, aluminum nitride and other non-oxide powders and whiskers; to the latter category belong beta-silicon carbide, aluminum nitride, boron nitride; and special powders based on titanium diboride for coating applications. Abundant inexpensive energy sources and availability of raw materials are expected to encourage growth in this area. In advanced functional ceramics, Canadian companies have specialized in piezoelectrics, both in component form and as systems, e.g., transducers and sensors. However, one large international company specializes in capacitors. New industrial interest includes manufacture of sapphire and opto-electronic materials.

Many traditional ceramics manufacturers are using their considerable technical and marketing skills to diversify product lines to include advanced structural ceramics. Most of the new products are based on alumina, zirconia and silicates; however, R&D is in progress to develop and commercialize non-oxide ceramics. The newer companies tend to concentrate on transformation-toughened oxide ceramics; non-oxide ceramics such as boron nitride, silicon nitride; ceramic-ceramic composites; and ceramic-metal joining.

Well-established industrial facilities exist for the deposition of advanced ceramic coatings using thermal and plasma techniques. Many aerospace companies have in-house facilities. Commercial coating facilities serve the aircraft industry and other industrial sectors that can take advantage of abrasion/wear/corrosion-resistant coatings (e.g., the pulp and paper, chemical, mining and machinery industries). The increasing industrial interest in plasma coating is responsible for expanding the activities of existing companies and bringing about the creation of new enterprises.

Information gleaned from the survey generating this directory indicates that Canadian industry is active in developing new technology and new markets for advanced ceramics. Significant growth is expected in the next few years as a result of diversification by the existing manufacturers and by the entry of new enterprises.

R&D Activities

Canada's significant heritage in the field of advanced ceramics is reflected by the fact that approximately 10 percent of research published in the Journal of the American Ceramic Society in the last 10 years has been by Canadian scientists. This emphasis on science and technology is expected to play an important role in the growth of advanced ceramics in Canada in the coming decade. Extensive R&D capabilities and facilities in advanced ceramics available in Canadian universities, federal government laboratories and provincial research organizations complement and support industry efforts to meet growing domestic needs as well as to increase export opportunities. Fourteen Canadian universities are active in advanced ceramics research and development, in addition to providing undergraduate and graduate studies. Support for university R&D comes both from industry and government departments or agencies. Many of the university professors have well-established international reputations.

Federal government laboratories in Canada boast a wealth of expertise in advanced ceramics and related industrial technologies. In addition to performing their own research and sharing in cooperative research and development projects, many of these departments and agencies fund research projects undertaken by industry and universities.

Four provincial research organizations carry out basic and applied research programs in advanced ceramics. In addition, they contract out to industry to develop new products and processes and to improve efficiency and productivity of operations.

Industry Associations

The increased participation of Canadian industry in the growing field of advanced ceramics is reflected by the formation of new national associations supplementing the 85-year-old Canadian Ceramic Society. These include the Advanced Materials Technology Unit at Queen's University, the Canadian University-Industry Council on Advanced Ceramics, the Canadian Advanced Industrial Materials Forum and the Ontario Centre for Materials Research. These associations should convince Canadian industry of the advantages of using advanced ceramics to improve operations, to expand existing businesses and to serve growing domestic requirements as well as to promote export market development. .

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COMPANIES

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Alcan Smelters and Chemicals Limited

Alcan Smelters and Chemicals Limited, a subsidiary of Alcan Aluminum Limited, is an integrated global enterprise, with management dedicated to ensure that Alcan Smelters's various chemical operations share technology, product knowledge and product development efforts.

Canadian operation locations include Jonquière in Quebec, and Ottawa and Brockville in Ontario. In the U.K., BA Chemicals manufactures alumina-based chemicals for the U.K. and European markets.

Alcan's 50 percent ownership of Nipon Light Metal Company Ltd. in Japan provides access to products and processes in the speciality alumina and hydrate field. NLM's Shimizu Works produces a wide range of high-quality aluminum hydroxides and aluminas for the world market. It is also involved in the manufacture of caustic soda, chlorine and derivatives.

Zirconia and zirconium chemicals are manufactured by Magnesium Elektron both in the U.K. and in the U.S.

Chemicals research and development work is done at Chalfont Park, England, Kingston Research and Development Centre, Canada, and at plant laboratories in Burtisland, England, Jonquière, Canada, and Shimizu, Japan.

Specialization

Alcan Smelters and Chemicals Limited specializes in the following areas:

- traditional ceramic-oxide raw materials for refractories, insulators and whitewares;
- advanced ceramic-oxide powders for the ceramic industry;
- research and development on non-oxide powders and whiskers.

Alcan Aluminum Limited and its subsidiaries have major interests in Lanxide TM technology and plan to set up manufacturing operations to use this technology.

Products

Alcan Smelters and Chemicals Limited produces a diverse range of chemical products:

- o normal and low soda alumina of varied crystal shape and size;
- reactive aluminas for advanced ceramic applications;
- magnesium alloys and zirconium-based chemicals for advanced ceramics.

Produced in Canada, the U.K. and Japan, these products are used in refractories, ceramics, pulp and paper manufacturing, pharmaceuticals, flame retardants, paint pigments, insecticides, water purification, textiles, leather treatment, thermal insulation and electrical insultation.

International Experience

Alcan Smelters and Chemicals Limited products are manufactured in various international locations and sold worldwide.

For further information:

Alcan Smelters and Chemicals Limited 1188 Shebrooke Street East Montreal, Quebec Canada H3A 3G2 Tel.: (514) 848-8000 Fax: (514) 848-8116 Telex:05-25236 ALCAN MTL

Almax Industries Limited

Almax Industries Limited is a wholly Canadian-owned company, employing about 100 people as of 1987. Founded in 1974 by Dr. G. Sinclair and K. El-Assal to provide a solid base for the manufacture of electronic ceramics in Canada, it is now a leading manufacturer of piezoelectric ceramics in North America.

The company has an active in-house R&D group, in keeping with its belief in the importance of research and development to create new technologies and products. In addition, it has strong ties with universities and government laboratories in other countries.

Almax Industries received the Canadian government "Award for Excellence in Technology Transfer" in 1986 for developing new products based on technology transferred from government laboratories.

Specialization

Almax Industries Limited develops and manufactures electronic ceramic products, including modified piezoelectric ceramics made from lead zirconate titanate compositions for use in high frequency resonators, superconductors and specialized sensors.

Products

Almax specializes in the manufacture of the following products:

• Lead zirconate titanate (PZT):

Several modified forms of PZT compositions, under the trademark Ai-4, Ai-5 and Ai-8, are in production. Designed mainly for use in anti-submarine warfare, these products are qualified to meet U.S. and Canadian navy standards. High-frequency ceramics:

Several proprietary compositions have been developed for use in resonators and filters at a frequency between 1 and 10 GHz. New products are being developed to operate up to 100 MHz.

• Superconducting ceramics and powders:

Superconducting ceramics, both in the monolithic form and powders, are being produced to meet the needs of design engineers. Educational kits for use by the general public, universities and colleges are being manufactured.

Sensor products:

Almax, through joint agreements, offers many specialized ceramics for sensors that can operate from sub-zero to 1000°C.

International Experience

The company has established technologytransfer agreements with several companies in France, India, England, Denmark, Israel and Japan.

For further information:

Mr. Kamal El-Assal General Manager Almax Industries Limited 61 Needham Street Lindsay, Ontario Canada K9V 4Z7 Tel.: (705) 324-5100 Telex: 06-962907 Fax: (705) 324-8354

B.M. Hi-Tech Inc.

B.M. Hi-Tech Inc. 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. There are 10 staff members.

Specialization

B.M. Hi-Tech Inc. produces a full range of advanced piezoelectric materials and acoustic components including sensors, that have been developed through close co-operation with its customers. Other products made by the company include glasses for infra-red applications and specialty electronic ceramics.

To continue extending the state-of-the-art materials technology, B.M. Hi-Tech's research and development group is constantly looking at new materials and process technology.

Products and Services

Products

- piezoelectric ceramics: modified compositions of lead zirconate titanate (PZT), leadmetaniobate (PMN) and lead titanate (PT);
- non-destructive evaluation (NDE) components to 50 MHz;
- Infrared (IR) glasses, glass ceramics and laser materials;

- sensors and devices: monolithic, multilayer and composites;
- process instrumentation: high-temperature process instrumentation and customdesigned systems.

Services

- custom fabrication of ceramic materials and components;
- pressure sintering;
- o silver, gold and nickel metallization;
- MILitary STandarDs (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:

Dr. S. E. Prasad President B.M. Hi-Tech Inc. P.O. Box 97 12 Stewart Road Collingwood, Ontario Canada L9Y 3Z4 Tel.: (705) 444-1440 Fax: (705) 445-4832

Cancarb Limited

Cancarb Limited, a wholly-owned subsidiary of TransCanada PipeLines Limited, is the world's largest manufacturer of high-quality carbon black sold under the trade name "Thermax". With its head office in Vancouver, B.C. and its manufacturing plant in Medicine Hat, Alberta, it produces about 70 million pounds of carbon black products each year. The company employs 52 people.

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

Mr. A. R. Steele President Cancarb Limited 1007 - 750 West Pender Street Vancouver, B.C. Canada V6C 2T8 Tel.: (604) 684-6571 Fax: (604) 684-3537

Ceramics Kingston Inc.

Ceramics Kingston Inc., a dynamic high-tech corporation, is privately owned with a broad shareholder base. Its location in Kingston, Ontario, is ideal from which to serve the many industries in the industrial southeastern 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 (see page 75), and is especially interested in international and national projects for mutual advantage with other companies.

Specialization

Ceramic 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 Tel.: (613) 548-7253

Crystar Research Inc.

Crystar Research Inc. of Victoria, B.C. is a subsidiary of Cominco Ltd. Established in 1987, with a technical staff of five, this company brings 25 years of electronic materials experience to the field of advanced optical materials.

Facilities include a Czochralski crystal puller 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 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 niobate.

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 and ruby crystals are used for solid-state laser applications. KTP, BBO and lithium niobate 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. Its products are custommade and are destined for international markets.

For Further Information:

Mr. Robert F. Redden President Crystar Research Inc. 721 Vanalman Avenue Victoria, B.C. Canada V8Z 3B6 Tel.: (604) 479-9922 Fax: (604) 479-2734

* YAG = yttrium aluminum garnet YIG = yttrium iron garnet GGG = gadolium galium garnet

Datco Technology Limited

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.

It is also active in the development and application of advanced ceramics.

Datco's fire-resistant coatings, developed with financial support from the Canadian Department of National Defence, are attracting interest for use in both Canadian and foreign naval vessels. A modified version of the coatings, which promises to reduce fire hazards dramatically in home and industry, is being evaluated for commercial markets in Canada and the U.S.

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:

Mr. Dave Nguyen Project Manager Datco Technology Limited 1220 Corporate Drive Burlington, Ontario Canada L7L 1J1 Tel.: (416) 332-1807 Fax: (416) 332-5506 Telex: 06-18963

EDO Canada Ltd.

EDO Canada Ltd., a wholly-owned subsidiary of EDO Corporation of New York, NY, U.S., started its operations in 1983 as a manufacturer of electronic instrumentation. In December 1987, the ownership as well as the objectives of EDO Canada underwent change. It is now jointly owned by the Province of Alberta and EDO Corporation. The operations have been expanded to include the development and manufacture of advanced composites and advanced structural ceramics.

In order to implement the expanded objectives, EDO Canada Ltd. will operate three divisions:

- Defence Electronics
- Advanced Composites
- Structural Ceramics.

The electronics division will continue to manufacture electronics instrumentation.

The advanced composite division was recently awarded a contract by the Canadian Armed Forces to produce 480 Gallon External Fuel Tanks for the CF-18 Fighter Aircraft. Both the technology and product lines are being provided by EDO Corporation from its U.S. operations as part of the joint venture agreement with the Alberta Government.

The Structural ceramics Divion is developing the technology to injection mold complex ceramic shapes. EDO Canada will offer the capability to produce components with difficult to manufacture geometries such as threads, bores, and counterbores from various directions and rapidly changing cross sections. Initially, EDO will concentrate on using alumina (Al₂O₃), zirconia (Zro₂), and silicon carbide (SiC) materials, but will eventually pursue new ventures with fibre reinforced ceramic composites and ceramic superconductors.

EDO Canada Ltd. plans to establish an R&D laboratory for the development of technology and new products.

Specialization

EDO Canada Ltd. is expanding its product lines to include advanced composites and advanced structural ceramics for aerospace and defence applications.

Products

Details of advanced composite and advanced structural ceramic product lines are still being established.

International Experience

EDO Canada Ltd. has been active in international markets since its inception, selling satellite positioning instruments. Historically, 70 percent of the sales have been in the international market. The company hopes to sell advanced composite and advanced structural products globally using the experience and expertise of one of the joint venture participants, the EDO Corporation.

For Further Information:

Dr. Joe Nemeth Technical Director Structural Ceramics EDO Canada Ltd. 1940 Centre Ave. N.E. Calgary, Alberta Canada T2E 0H7 Tel.: (403) 569-5400 Telex: 03-825895 Fax: (403) 569-5499

Electrofuel Manufacturing Company Limited

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 10000 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 LiAl-FeS batteries;
- electrochemical devices;
- design and construction of hightemperature furnaces (high-pressure hot press); controlled atmosphere high-pressure capability; microgravity space capability;
- o 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;
- o 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

Electrofuel maintains marketing and technical contacts in Canada, the U.S., Japan and Europe. Its products are sold both directly and through its various distributors.

For Further Information:

Dr. S. Das Gupta, President Electrofuel Manufacturing Company Ltd. 9 Hanna Avenue Toronto, Ontario Canada M6K 1W8 Tel.: (416) 535-1114 Fax: (416) 535-2361

EYC Industries Limited

EYC Industries Limited was established in 1984 in Espanola, Ontario, to provide wear- and heat-resistant ceramic tiles for the resource industries of Northern Ontario. Almax Industries (see page 4) acquired the company in 1986. In 1987, the staff numbered eight.

Specialization

Within its specialty of the development and manufacture of structural ceramics, EYC Industries has adapted slip-casting and pressing (isostatic as well as uniaxial) techniques for the manufacture of these highdensity ceramics. The main products at present are alumina ceramics with densities varying in the range of 45 to 98 percent. However, products based on partially stabilized zirconia (PSZ), as well as non-oxide structural ceramics based on silicon carbide and silicon nitride, are under development.

Products

The following products are now being manufactured:

- Slip cast ware is the main product line at the Espanola facility: high-purity alumina crucibles and kiln furniture are manufactured to customer specifications of density and size;
- Wear tiles are currently handled as a resale product, but some speciality tubes are manufactured in-house;
- Machined ceramics: the Lindsay facility has carbide and diamond machining capabilities to produce precision components of alumina and zirconia ceramics. A major expansion is planned to produce wear components and valves for customers in Western Canada;

- Filter plates: EYC has developed ceramic membranes for specialized use in persulfuric acid production; electrolytic sensors; high-temperature alkali electrolysis; and extreme-temperature gas filtering;
- Armour plates: EYC has developed a proprietary casting and sintering procedure that produces a thick outer layer in the manufacture of toughened alumina products. If necessary, the material can be machined to the required configuration in the pre-fired state;
- High-temperature kiln: under licence from a French company, EYC manufactures a high-temperature laboratory kiln that will operate in an oxidizing or neutral atmosphere at 2200°C. The kiln is available in several sizes.

International Experience

EYC Industries Limited has acquired international exposure through its parent company, Almax Industries Limited. Although only 50 percent of sales is exported, the customer base is very wide.

For Further Information:

Mr. Kamal El-Assal General Manager or Dr. Bruno Kindl Manager, R&D **EYC** Industries Limited Box 1053 52 Mount Hope Street Lindsay, Ontario Canada K9V 4W9 Tel.: (705) 324-4132 Fax: (705) 324-8354 Telex: 06-962907

Hamilton Porcelains Limited is a privatelyowned Canadian company which began operations in 1852. 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 140 people.

At present, the company operates three 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.

The third facility, Brantford Heaters Limited, manufactures a complete line of gas-fired and electric infrared radiant heaters.

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 1500 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 arcchute 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 metals 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
Mr. P. Robins, Technical Director
Mr. J. Mason, Technical Sales
Hamilton Porcelains Limited
25 Campbell Street
P.O. Box 594
Brantford, Ontario
Canada N3T 5N9
Tel.: (519) 753-8454
Fax: (519) 753-5014
Telex: 061-81194 (HAMPO)

Hard Materials Research Inc.

Hard Materials Research Inc. is a Canadian company which started its operations in 1986. It is jointly owned by Boart Canada Inc., a manufacturer of mine drilling equipment and related products, and Chadrien Ltd., an engineering consulting company. Its objectives are to provide contract R&D services to industry and government, and to develop new technology and materials for commercial exploitation.

The Mississauga, Ontario facility of HMR houses pilot-scale equipment for blending, milling, drying and granulation of hard-metal powders, as well as the pressing and sintering of cemented carbide components. The total staff complement, at present four, is expected to increase as demand for services grows.

Specialization

Hard Materials Research Inc. specializes in the selection and development of abrasion and wear-resistant materials and products for the mining industry and other specialized applications.

Services

At present, Hard Materials Research Inc. provides services in the following areas:

- evaluation of wear problems;
- development of specialized hard materials;
- production and testing of cemented carbide products;
- technical and economic surveys and feasibility studies.

The company maintains close ties with universities and government research establishments and also has access to the facilities and expertise of its parent companies.

For Further Information:

Mr. G. W. Mochrie, Vice President
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Hard Materials Research Inc.
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Telex: 06-982434

Inco Limited

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 1987, it employed about 20 170 people. The net sales for 1986 were about US\$ 1.45 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 hightemperature 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., England, Europe, Japan, Australia, Taiwan and Hong Kong. Its products are sold throughout the world.

For Further Information:

Dr. J. A. E. Bell Director J. Roy Gordon Research Laboratory Inco Limited Sheridan Park, Ontario Canada L5K 1Z9 Tel.: (416) 822-3322 Fax: (416) 822-0533 Telex: 06-982263

Industrial Ceramics Limited

Industrial Ceramics Limited, established in 1946, is wholly Canadian-owned, with a U.S. subsidiary. It has recently enlarged its R&D activities to take advantage of new opportunities for advanced ceramics products. In addition to its in-house activities, it uses the services of other research and development establishments such as Ortech International.

The manufacturing plant and the R&D laboratories are in Mississauga, Ontario. The company employs three technical staff and about 20 production workers.

Specialization

Industrial Ceramics Limited specializes in the manufacture of speciality advanced ceramic products based on alumina, zirconia, zircon and magnesia compositions. It also acts as a manufacturer's representative for speciality products not made in-house and provides consulting services in the use of ceramic products.

Products

The present product lines include special refractory shapes in alumina, zirconia, zircon and magnesia. These are made using isostatic pressing, uniaxial pressing, extrusion and casting techniques followed by sintering.

International Experience

The company has been marketing its products throughout the world for over 25 years.

For Further Information:

Mr. H. John Lawrence President Industrial Ceramics Limited 473 Hensall Circle Mississauga, Ontario Canada L5A 1X9 Tel.: (416) 276- 5447 Telex: 06-960196

JaCoat Company

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:

Mr. D. C. Radford Manager JaCoat Company 146 Hickson Avenue P.O. Box 63 Kingston, Ontario Canada K7L 4V6 Tel.: (613) 548-3128 Fax: (613) 542-1345

Jay-Em Ceramics

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 an 80 kW Metco Plasma unit with supporting equipment. At present, production and laboratory facilities occupy about 1000 square feet, but a move to larger premises is in the offing.

With a total staff of four, Jay-Em Ceramics holds a unique position amongst plasmacoating 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 coatings to resist wear, abrasion and corrosion.

The company provides standard state-of-theart 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 the aerospace, automotive, electrical and electronics, pulp 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 on superconducting advanced ceramic films.

For Further Information:

Mr. Suktek Johar General Manager Jay-Em Ceramics 8 Melanie Drive, #8 Brampton, Ontario Canada L6T 4L2 Tel.: (416) 458-8638 or (416) 451-3200

Kennametal Ltd.

Kennametal Ltd. 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 offices and/or distributors are located all across Canada.

Kennametal Ltd. employs 230 people including five in R&D and engineering and about 110 production workers (30 in Toronto and 80 in Langford).

Specialization

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

Products and Services

Kennametal Ltd. markets all the products and services available through its parent company, Kennametal Inc., an established leading manufacturer of metal-cutting and metalforming products, and other abrasion-, wearand 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 Ltd. 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. (see page 21).

International Experience

Kennametal Ltd.'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:

Dr. G. W. Roland Vice-President and Managing Director Kennametal Ltd. 1425 The Queensway Toronto, Ontario Canada M8Z 1T4 Tel.: (416) 252-7851 Fax: (416) 252-4034 Telex: 06-984504

Lakeside Electronics Ltd.

Lakeside Electronics Ltd. 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 Ltd. specializes in the manufacture of lead zirconate titamate (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 depthsounding 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:

Mr. Al J. Ankus, PEng President Lakeside Electronics Ltd. 321 Hopkins Street Whitby, Ontario Canada L1N 2C1 Tel.: (416) 668-2981

Macro Division of Kennametal Inc.

Macro Division of Kennametal Inc. is a division of Kennametal Inc., of the U.S. Established in 1952 by Mr. Philip McKenna in Port Coquitlam, B.C., it now employs about 60 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 produces and markets four broad varieties of product:

- intermediate carbides and nitrides such as WC, TiC, WC/TiC, TaC, 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:

Mr. James D. Morris Marketing Manager Macro Division of Kennametal Inc. 1651 Kingsway Avenue Port Coquitlam, B.C. Canada V3C 1S3 Tel.: (604) 941-9611 Fax: (604) 941-3525 Telex: 04-353516 Cable: MICRON, PORT COQUITLAM

Metal 7 Inc.

Founded in 1975, Metal 7 Inc. is a Canadian company with its head office and plant in Sept-Îles, Quebec. It started as a machine and metalworking 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 plasmacoating equipment.

The company employs 40 people: 26 production staff and 10 engineering staff.

The sales of ceramic-coated components have increased from five percent of sales in 1981 to about 75 percent in 1987, and are expected to grow.

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.

Products

The company manufactures original parts and components. It also provides refinishing services.

Almost 80 percent 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 grates, 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.

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 percent of its production all around the world, including the U.S., Sweden, the Netherlands and India. It plans to expand its sales to Liberia, Mexico and Turkey.

For Further Information:

Mr. Charles Bigonesse, General Manager or Mr. Denis Belley, Engineering Department Metal 7 Inc. P.O. Box 1590 285 des Pionniers Sept-Îles, Quebec Canada G4R 4X9 Tel.: (418) 968-5822 Fax: (418) 962-4534 Telex: 051-8-4130

Montreal Carbide Co. Ltd.

Montreal Carbide Co. Ltd. is a Canadianowned company incorporated in 1980. The manufacturing and R&D facilities, in Anjou, Quebec, with a staff of six occupy 4200 square feet of laboratory and plant space. The head office is in Saint-Bruno, Quebec.

Specialization

Montreal Carbide specializes in the development 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 B_4C) wear-resistant parts and components.

Products

• Wear parts:

Sandblast nozzles made of tungsten carbide and boron carbide.

• Powders:

Specialized powders for reactive plasmaspraying of wear-resistant titanium diboride-in-metal-matrix coatings are under development. These will 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.

International Experience

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

For Further Information:

Mr. Peter Kalisky President Montreal Carbide Co. Ltd. 850 Place Des Grands Ducs Saint-Bruno, Quebec Canada J3V 4P6 Tel.: (514) 461-1298 Fax: (514) 355-7478 Telex: 05-828606 NATCAIR MTL

MPB Technologies Inc.

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:

- Centorr 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-toceramic and ceramic-to-metal (kovar, stainless steel, platinum, etc.) seals.

A typical example of a 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-toglass 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 Tel.: (514) 683-1490 Fax: (514) 683-1727 Telex: 05-823509 Cable: MPBTCAN (Montreal)

Murata Erie N.A. Ltd.

Murata Erie N.A. Ltd., 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 25 years. High-voltage multipliers and power supplies have been manufactured in its Toronto facility for more than 17 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 1 000 people.

Specialization

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

Products

Products manufactured by Murata Erie include:

- low-pass EMI filters;
- voltage multipliers and high-voltage power supplies;
- filtered connectors and filter arrays.

International Experience

Murata Erie N.A. Ltd. has sales offices throughout North America and is represented worldwide by Murata Manufacturing Co. (its parent company) and its various subsidiaries, sales offices and distributors.

For Further Information:

Mr. M. Blamire Trenton Operations Murata Erie N.A. Ltd. 5 Fraser Avenue Trenton, Ontario Canada K8V 5S1 Tel.: (613) 392-2581 Fax: (613) 392-0701 Telex: 06-62279

Neosid (Canada) Limited

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 a larger office and laboratory facilities. At present, the company employs between 20 and 30 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. R. Lang, President Mr. G. Jones, Sales Manager Neosid (Canada) Limited 10 Vansco Road Toronto, Ontario Canada M8Z 5J4 Tel.: (416) 251-2831 Fax: (416) 251-6790

 Toll-free
 telephone
 numbers:

 U.S.:
 1-800-387-7213

 Ontario:
 1-800-387-7384

 Quebec:
 1-800-387-7384

Noranda Inc.

Noranda Research Centre is the corporate research and development unit of Noranda Inc., a Canadian natural resource company operating worldwide.

Noranda's major business encompasses metals and minerals, oil and gas, forest products and manufacturing. Manufacturing interests include electrical wire and cable products, fibre optics systems, copper and alloy strip, rod and tube, aluminum sheet and foil, aluminum building products, steel wire rope and cordage products.

The Noranda Research Centre plays an important role in seeking new business opportunities in advanced materials.

Specialization

Noranda Research Centre specializes in research, development and application technology in mining, mineral processing, metals extraction, metals application and manufacturing.

Other R&D facilities attached to individual companies of the Noranda Group include centres specializing in forest products, electric conductors and fibre optics.

Services

The Noranda Research Centre discovers, develops and adapts innovative technology for the production and use of natural resources to improve productivity, recovery, efficiency, product quality and competitiveness while respecting the environment. Its activities include:

 zinc alloy development and analysis of characteristics;

- development of zinc coatings technology and performance evaluation;
- development of new metal-casting technology, including die casting, strip casting and solidification;
- study of optoelectronic materials and systems.

In advanced ceramics, the centre is studying superconductors and structural ceramics, particularly for abrasion and wear-resistant applications.

For Further Information:

Mr. D. Herscovitch Noranda Research Centre 240 Hymus Boulevard Pointe-Claire, Quebec Canada H9R 1G5 Tel.: (514) 697-6640 Fax: (514) 697-9589 Telex: 05822647

Northern Pigment Co.

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 employs 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:

J. M. Cooke, President

W. H. Nord Vice President - Operations

R. DeMarchi, Manager, Sales & Marketing

P. Duncker Manager, R&D

Northern Pigment Co. 36 Towns Road Toronto, Ontario Canada M8Z 1A3 Tel.: (416) 251-1161 Fax: (416) 251-4774
Norton Advanced Ceramics Canada, Inc.

Norton Advanced Ceramics Canada, Inc. is wholly owned by Norton Company of the U.S. (head offices in Worcester, MA) which also operates a research and development centre in Chippawa, Ontario. The centre has a staff of 30 to 40 people.

Norton Company operations are grouped into abrasives, engineering materials, and petroleum and mining.

Specialization

Norton Advanced Ceramics Canada specializes in technical assistance in the selection and use of advanced ceramic components and products for specific industrial applications; market research and business development expertise from development to commercialization; and sale of advanced ceramic components and products manufactured by Norton Company. Norton also manufactures silicon carbide and zirconia-alumina materials in Canada, which are processed in the U.S.

Products

Norton Company products are:

- abrasives: bonded grinding wheels, coated abrasives, construction products, diamond wheels and tools;
- engineering materials: chemical process products, health care products, highperformance ceramics, industrial ceramics materials, performance plastics;
- petroleum and mining: drilling products, drilling systems, mining products and services, proppants and well services.

International Experience

Norton Company, a dynamic, diversified manufacturer with 20 000 employees worldwide, operates 127 plants in 28 countries.

For Further Information:

K. P. Fellinger
Materials Sales Manager - Canada
Norton Advanced Ceramics Canada, Inc.
8001 Daly Street
Niagara Falls, Ontario
Canada L2G 6S2
Tel.: (416) 295-4311
Fax: (416) 295-4311 Ext. 246

Ontario Hydro (Research Division)

Ontario Hydro, a Crown corporation, is one of the largest producers of electrical energy for Ontario. Its generating capacity amounts to 25 000 MW, from a mix of nuclear, fossil and hydro plants. A transmission and distribution network spans all parts of the province. Ontario Hydro seeks to provide electrical energy at the lowest cost possible to meet customer requirements.

An in-house staff of about 630 people in the research division carries out engineering and technology research and development. The ceramic activities are supported by a staff of six.

Specialization

The Ontario Hydro Research Division provides technical and R&D 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. Specifically, the advanced ceramics group is working on the development of plasma (plasma arc and radio frequency (RF) plasma) to provide advanced ceramic powders and coatings, microwavedrying and sintering-process technologies.

The researchers are applying tribological and corrosion expertise to improve advanced ceramics within the Ontario Hydro electric power systems.

Products and Services

The main product of interest to the ceramics industry is the supply of economical and reliable electric power for the manufacture of advanced ceramic powders and components.

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.

For Further Information:

Dr. C. S. Simpson Special Projects Ontario Hydro 800 Kipling Avenue Toronto, Ontario Canada M8Z 5S4 Tel.: (416) 231-4111 Fax: (416) 231-9679 Telex: 06-984706

Peacock Inc.

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 aroundthe-clock specialized repair and rebuild service for a wide range of industrial equipment.

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.

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;
- o hard surfacing;

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

For Further Information:

Mr. M. Sikich General Manager Peacock Inc. 1180 Aerowood Drive Mississauga, Ontario Canada L4W 1Y5 Tel.: (416) 625-7100 Fax: (416) 625-7203 Telex: 06-961291 Plasma & Flame Coatings Ltd. is a wholly Canadian-owned company, started in 1971 inWinnipeg. Its founder and president, Mr. J.W. H. Blott, had acquired extensiveexperience in plasma coatings in the 16 yearshe worked as an engineer with Metcooperations in Canada.

The plant occupies about 18 000 square feet of space with a staff complement of 25. Five Metco plasma units, with capacity ranges to 80 kW, are in use, with one spare. The company is strongly R&D oriented to meet the diversified needs of its customers.

The company's subsidiary, Plasma & Flame Spray North Dakota Inc., located in Minot, ND, U.S., provides services to the oil and gas, and coal mining industry.

Specialization

Plasma & Flame Coatings Ltd. specializes in plasma coatings for thermal, wear and corrosion-resistant applications for the aircraft, oil and gas exploration, pulp and paper, petrochemicals, mining and machinery industries. In addition, the company manufactures original parts and components.

Services and Products

Plasma & Flame Coatings Ltd. provides custom plasma coating services for thermal, wear and corrosion resistant applications. The company repairs, maintains and overhauls aircraft engine parts and components for clients such as Bristol Aerospace and Standard Aero in Winnipeg and IMP Ltd. in Halifax, N.S. All types of engines (e.g., Rolls Royce, Pratt & Whitney and General Electric) are serviced. The pulp and paper industry is a very important sector for which the company provides specialized original plasma sprayed components as well as repair and maintenance services.

In the oil and gas and petrochemical industries, the company does plasma coating for pump components, diesel engine components and on-site coatings for corrosion protection for critical areas.

Wear and abrasion protection coating services are also provided in the mining and machinery industries for bearings, industrial fan components, etc.

For Further Information:

Mr. J. W. H. Blott President Plasma & Flame Coatings Ltd. 1975 Logan Avenue Winnipeg, Manitoba Canada R1R 0H8 Tel.: (204) 632-5585 Fax: (204) 943-6915

Polyceram Inc.

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:

Dr. Alain Dubreuil President Polyceram Inc. P.O. Box 6079, Branch A Montreal, Quebec Canada H3C 3A7 Tel.: (514) 340-4988 Fax: (514) 340-4026 Telex: 05-24146

Powerplex Technologies Inc.

Powerplex Technologies Inc. is a joint venture of Magna International Inc. (Toronto, Ontario, Canada) and ASEA, Brown, Boveri of West Germany, formerly Brown, Boveri & Cie. Incorporated in 1984, the company employs about 35 people in its 20 000 square-foot R&D facility in Toronto.

The controlling partner, Magna International Inc., is the largest automotive parts manufacturer in Canada with annual sales exceeding \$1 billion. Magna designs, develops and manufactures automotive components and systems for sale mainly to the North American original equipment manufacturers. ASEA, Brown, Boveri is primarily involved in the design, development and manufacturing of electrical products ranging from turn-key power generation plants to microelectronics.

Powerplex has an exclusive agreement with ASEA, Brown, Boveri jointly to develop Na-S batteries and electric drive-trains for the North American market.

Specialization

Powerplex Technologies Inc. specializes in the development and manufacture of high-energy sodium-sulphur batteries for electric vehicles and for energy storage applications.

Activities

Powerplex Technologies is involved in all aspects of Na-S battery development including microelectronics, electrochemistry and beta-alumina ceramics. At present, current activities in advanced ceramics are focussed on improving the performance of ceramic electrolyte under the hightemperature, highly corrosive conditions in an electrochemical Na-S battery cell. Volume production of beta-alumina electrolyte is planned for the future.

Products

The following products are under development for use in the Na-S battery:

- beta-alumina ceramic electrolytes, sulfur/graphite composite components;
- thermal insulation systems;
- high-temperature microelectronic components;
- thermal management systems.

International Experience

Powerplex Technologies Inc. is in constant contact with various R&D organizations throughout the world. Its sodium-sulfur battery development project is regarded as one of the leading high-energy battery technologies in the world today.

For Further Information:

Dr. Alina Pekarsky Manager, Ceramic Development Powerplex Technologies Inc. 257 Wildcat Road Downsview, Ontario Canada M3J 2S3 Tel.: (416) 736-4994 Fax: (416) 736-0987 Telex: 06-218835 Founded in 1955, Quality Hermetics Company was acquired by Leigh Instruments Limited in 1969. It is unique in Canada as the only manufacturer of glass and glassceramic 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 25.

For 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 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 specializes in the design and manufacture of hermetic feedthroughs, 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 feed-throughs 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 has concentrated on the Canadian and North American markets; it is now entering markets in Europe and the United Kingdom using agents and representatives of Leigh Instruments, its parent company.

For Further Information:

Mr. Keith Elliott General Manager or Mr. Anthony DeSantis Engineering Manager Quality Hermetics Company 45 Hollinger Road Toronto, Ontario Canada M4B 3G4 Tel: (416) 757-2869 Fax: (416) 757-6503

Sherritt Gordon Mines Limited

The major plants of Sherritt Gordon Mines Limited in Fort Saskatchewan, Alberta, comprise a nickel and cobalt refinery, a coinage and rolling mill plant, a fertilizer complex, a special products division and the research centre. In total, approximately 950 people are employed. The research centre, with about 75 people, supports all operating divisions and conducts a wide range of programs, principally to develop proprietary processes for the recovery and refinement of metals, and to develop new proprietary technologies. Sherritt's technology reaches the marketplace through the special products division, which produces and sells secondary metal products, and through the external technology group, which licences the metallurgical processes to interested customers.

Specialization

Sherritt's activities in advanced ceramics are presently limited to the research centre and the special products division in Fort Saskatchewan. Here they use their proprietary hydrometallurgy technology and processing expertise to produce fine metal and composite powders.

Products and Services

Sherritt's products related to advanced ceramics are at present limited to composite powders comprising virtually any ceramic core encapsulated in an outer coating of nickel, cobalt, copper or alloys of these metals, such as NiCrAl. The wide range of available composite powders has found an equally wide range of applications from Ni/Graphite and NiCrAl/Bentonite in aircraft turbine engine seals to Co/WC and NiCr/Cr₃C for wear resistance. Powder size and shape can be tailored to specific applications such as plasma spraying. In the research centre, some work has been done on the production of ultra-fine mixed oxide powders, but no products are currently offered for sale.

Through the external technology group, Sherritt provides extensive services for the development of hydrometallurgy processes for the recovery and refinement of metals. These services include basic laboratory studies, piloting, plant design and start-up assistance. Plants using Sherritt technology worldwide now include operations producing nickel, cobalt, zinc, uranium, platinum and gold.

International Experience

The markets for specialty metal products and external technology services, largely international, are maintained by Sherritt's substantial force of well-qualified technical people from the Fort Saskatchewan base. Routine sales and some development work are carried out in most major overseas markets through appointed agents.

For Further Information:

Dr. M. A. Clegg, Director Sherritt Research Centre

Mr. D. G. Maschmeyer Vice President, Special Products Division

Sherritt Gordon Mines Ltd. Fort Saskatchewan, Alberta Canada T8L 2P2 Tel.: (403) 998-6911 Fax: (403) 998-6568 Telex: 037-2290 Standard Aero Limited is a division of Avcorp Industries Inc., a diversified Canadian aerospace company involved in production and servicing of metal, composite and specialized plastic components used in the aerospace industry.

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 Bellevue, 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:

Mr. Brent R. Junkin Engineering Technical Service Standard Aero Limited 33 Allen Dyne Road Winnipeg, Manitoba Canada R3H 1A1 Tel.: (204) 775-9711 Fax: (204) 783-5686 Telex: 07-57878

Vac-Aero International Inc.

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, semiautomatic and computer-controlled robotic plasma-coating techniques are used to achieve homogeneous coating deposits and uniform thickness. The division employs about 15 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 afterburner liners; and abradable seal coatings in high and low-compressor casings. Customers include Pratt & Whitney Canada, Rolls Royce and Air Canada. Vac-Aero provides industrial manufacturing coatings to other industry sectors including pulp and paper, chemical and pumps.

For Further Information:

Mr. L. Gosselin
General Manager
Quebec Division
Vac-Aero International Inc.
7450 Vérité Street
Saint-Laurent, Quebec
Canada H4S 1C5
Tel.: (514) 334-4240
Telex: 05-824750

Witteck Development Inc.

Witteck Development Inc. was established in 1981 as a privately-owned metallurgical and chemical laboratory to serve international mining and metallurgical industries. The facilities consist of metallurgical, analytical, petrographic and engineering labs, as well as pilot plant capability to test mineral ores and concentrates.

To take advantage of its experience in mineral benefication, particularly hydrometallurgy, the company has expanded its activities to include the synthesis of advanced ceramic powders.

Specialization

Witteck Development Inc. specializes in research and development to do with the production of yttria-stabilized zirconia used in the manufacture of advanced ceramics. It also has established modern ceramic testing facilities to provide custom service to its clients.

Services

The company provides R&D services, on contract basis, in the following areas:

- ceramic powder development;
- ceramic development and testing;
- mineral beneficiation;
- o hydrometallurgy;
- electrometallurgy;
- gold and silver technology;
- pilot plant design and operation;
- flow sheet development.

Analytical capabilities include:

- ores, concentrates, soils and waters;
- method development;
- on-site consultation.

Design engineering capabilities include:

- feasibility studies;
- plant modifications;
- pollution control;
- plant start-up.

International Experience

Witteck Development provides services to mining and mineral resource companies in Canada and in the international market.

For Further Information:

Mr. William Wittie President Witteck Development Inc. 2640 South Sheridan Way Mississauga, Ontario Canada L5J 2M4 Tel.: (416) 823-7381 Fax: (416) 823-5689

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ACADEMIC INSTITUTIONS

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Concordia University

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 PhD 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 and characterization of zeolite ceramics for catalysis applications (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);
- high T_c Superconductors (Dr. G. Denes).

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

For Further Information:

C. H. Langford	(514) 848-4802
Dr. M. F. Bell	(514) 848-3387
Dr. J. A. Capobianco	(514) 848-3350
Dr. G. Denes	(514) 848-3346
Dr. M. Lawrence	(514) 848-3374
Dr. B. Lombos	(514) 848-3085

Laboratories for Inorganic Materials Department of Chemistry Concordia University 1455 de Maisonneuve Blvd West Montréal, Quebec Canada H3G 1M8 Fax: (514) 848-3198

Dalhousie University

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 glasslike 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 lowfusing glassfeldspathic biomaterials;
- mechanism 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:

Dr. Derek W. Jones, PhD, FICeram, FRSC, FADM Professor and Head, Division of Dental Biomaterials Science Assistant Dean (Research) Faculty of Dentistry Dalhousie University Halifax, Nova Scotia Canada B3H 3J5 Tel: (902) 424-2545

École Polytechnique de Montréal

École 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 3210 undergraduates and 950 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 75 undergraduates and 48 graduate students in metallurgical and materials engineering.

Advanced Ceramics Research Programs

There are 22 people presently working in ceramics: six professors, (Drs. J. P. Bailon, C. Bale, J. I. Dickson, J. M. Drolet, A. Pelton and M. Rigaud), five research associates, two technicians and nine 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. Drolet);
- fabrication and applications (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 R&D contracts supported by government and industry include:

- development of Li and Na-probes for use in molten aluminum; development of Caconducting 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 carbonbonded 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:

Dr. J. P. Bailon	(514)	340-4260
Dr. C. W. Bale	(514)	340-4770
Dr. J. I. Dickson	(514)	340-4963
Dr. J. M. Drolet	(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 Montréal, Quebec Canada H3C 3A7 Telex: BIBPOLYTEC-MTL-05-24146 Fax: (514) 340-4440

Laval University

Laval University provides undergraduate and graduate instruction in sciences, engineering, medicine, business, arts and humanities. The university has 16 695 undergraduates and 5510 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 47 undergraduate and 37 graduate students specialized in ceramics. Students can specialize in ceramics at the graduate level leading to MSc and PhD degrees.

Advanced Ceramics Research Programs

Dr. Rock Angers and Dr. Réal 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.

For Further Information:

Dr. Rock Angers (418) 656-5385 Dr. Réal Tremblay (418) 656-5047

Department of Mining and Metallurgy Laval University Ste-Foy, Quebec Canada G1K 7P4

McGill University

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 composities. The degrees offered are BEng, MEng and PhD

Advanced Ceramic Research Programs

At present all the advanced ceramics R&D programs are carried out in the Department of Mining and Metallurgical Engineering under the leadership of Professor R. A. L. Drew. The interests of the Ceramics Group (10 full-time researchers, 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 Si₃N₄ powders;
- \circ processing and sintering of Si₃N₄;
- mechanics of slip casting;
- ceramic-metal joining;
- laser machining of ceramics;

- communition and sintering of reactive aluminas;
- metal-ceramic and ceramic-ceramic composities;
- sintering of metal powders.

For Further Information:

Dr. R. A. L. Drew Department of Mining and Metallurgical Engineering McGill University 3450 University Street Montréal, Quebec Canada H3A 2A7 Tel: (514) 398-4350 Telex: 05-268510

McMaster University

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 218 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 undergraduate and graduate programs in ceramic engineering. However, only the undergraduate course leads to the formal BEng (Ceramic Eng) degree. At present, there are 36 undergraduates in ceramic engineering.

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

Advanced Ceramic Research 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 of precursor powders for ceramic electrolytes and 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; bio-active glass/metal composites; and solid electrolytes (proton conducting) for fuel cells. Professor Wilkinson's interests are in the mechanical properties of ceramics and metals, particularly, damage processes at elevated temperatures.

Government and industry-supported R&D contracts include: ceramic/ceramic composites; damage and creep of alumina-based ceramics; development and character of Si_3N_4 microstructures; and sintering of super-conducting 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:

Dr. P. S. Nicholson (416) 525-9140 Ext. 4977 Dr. D. S. Wilkinson (416) 525-9140 Ext. 4293 Dr. G. P. Johari (416) 525-9140 Ext. 4941

Department of Materials Science and Engineering McMaster University 1280 Main Street West Hamilton, Ontario Canada L8S 4L7 Tel: (416) 525-9140 Fax: (416) 528-5030 Telex: 06-18347 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 10 000 and 1450, respectively.

No undergraduate degree is offered in ceramic engineering, although some courses in advanced ceramics and composite materials are available in the Department of 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 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 Advanced Materials Technology Unit, an inter-disciplinary organization, which provides liaison with industry.

Advanced Ceramic Research Programs

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

Professor Sayer is involved in the fabrication of electronic ceramics in thin film form using magnetron sputtering and chemical deposition techniques; thin film ceramic development, including surface acoustic wave and electrooptic materials; piezoelectric ceramics and the electrical properties of oxide, superconducting and fast ion ceramics in general; and polymer-ceramic composites. 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 electro-luminescent displays.

Professor D. A. Hutchins, also of the Department of Physics, directs a team concerned with non-destructive evaluation of materials by acoustic, laser/interferometric and electromagnetic methods.

Professor J. L. Whitton uses ion beam modification to fabricate surface coatings and to control the tribological and surface properties of materials. The Queen's 4MV Van de Graaff accelerator is used for analysis of ceramics by methods including Rutherford back-scattering, nuclear reaction analysis and proton induced X-ray emission.

In the Department of Metallurgical Engineering, research areas include: the mechanical properties of ceramics; ceramic moulds for metallurgical applications; and the processing of silicon carbide powders. Professor V. D. Krstic of this department is involved in: the processing of advanced ceramics and whisker reinforced composites; the mechanical properties of ceramics and brittle composites; and microstructure/materials properties.

For Further Information:

(613) 545-2693
(613) 545-2677
(613) 545-2695
(613) 545-2754

Queen's University Kingston, Ontario Canada K7L 3N6

Royal Military College of Canada

The Royal Military College of Canada provides undergraduate and graduate education in arts, science and engineering to 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 Ferroelectric Materials and in the Laboratory for Superconducting Materials, both of which are in the Department of Physics.

Advanced Ceramics Research Programs

The Ferroelectric Materials Group comprises four professors (Drs. H. D. Wiederick, B. K. Mukherjee, N. Gauthier and A. Lachaine) and one research assistant.

Dr. Wiederick and Dr. Mukherjee are currently setting up a laboratory for the complete characterization of the dielectric, piezoelectric, electrostrictive and pyroelectric properties of ceramic materials. Their current interests include:

- development of advanced piezoelectric ceramics (lead titanate family) and ceramic-polymer composites for use in sonar, non-destructive testing (NDT) and medical transducers;
- development of advanced pyroelectric ceramics for use in infrared detection and thermal imaging;
- development of electrostrictive ceramics, ultrasonic actuators and motors.

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 three professors (Drs. D. C. Baird, A. Batalla and L. W. Wright) and two research associates. Current interests include: critical current measurements by both AC and DC techniques; relationship between critical current and structure; and flux structures.

The research activity is supported by grants from the Chief of Research and Development, Department of National Defence and by contracts from Defence Research Establishments. Some of the work is being carried out in collaboration with Canadian industries.

For Further Information:

Dr. H. D. Wiederick	(613)	541-6434
Dr. B. K. Mukherjee	(613)	541-6348
Dr. D. C. Baird	(613)	541 - 6413
Dr. A. Batalla	(613)	541 - 6167
Dr. N. Gauthier	(613)	541-6332
Dr. A. Lachaine	(613)	541-6041
Dr. L. W. Wright	(613)	541-6340

Department of Physics Royal Military College of Canada Kingston, Ontario Canada K7K 5L0 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 Departments 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, electrocatalysts (for oxygen evolution) 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 coatings 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 Engineering Physics Technical University of Nova Scotia P.O. Box 1000 Halifax, Nova Scotia Canada B3J 2X4 Tel.: (902) 429-8300, Ext. 2206 Fax: (902) 429-8300 EMRL #2207

University of British Columbia

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 BASc, MASc and PhD degrees. There are between 60 and 70 undergraduate students 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 and I. V. Samarasekera, 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 slagresistant refractories (Dr. A. C. D. Chaklader);
- plasma synthesis and characterization of advanced ceramic powders (Dr. A. C. D. Chaklader);
- metal-ceramic interfacial reactions (Dr. A. C. D. Chaklader);
- thermal stress in ceramics; mathematical modelling of fused cast refractories (Dr. A. C. D. Chaklader, Dr. J. K. Brimacombe and Dr. I. V. Samarasekera).

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., CTF Systems Ltd., B.M. Hi-Tech Ltd. and Standard Oil Engineered Materials of the U.S.).

For Further Information:

Dr.	A.	C.	D. Chaklader	(604)	228 - 2705
Dr.	J.	Α.	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 Telex: 04-51233 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 carbonreinforced 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:

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 Tel.: (819) 821-7000 Fax: (819) 564-5643 Telex: 05-836149 BIBUNIVSHB

University of Toronto

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 the Departments of Chemistry and Metallurgy and Materials Science.

Graduate research in materials is carried out in a number of departments at the university and co-ordinated by the Co-ordinator of Materials Research who is in the Department of Metallurgy and Materials Science where much of the ceramics research is conducted. Work is also done in this area in the Department of Chemical Engineering and Applied Chemistry. The graduate programs lead to MEng, MASc and PhD degrees.

Advanced Ceramics Research Programs

The following programs are being conducted at the university:

• bonding of bioceramics (Prof. R. Pilliar);

- high-T_c superconductors (Professors Rutter and Barham);
- plasma-processing of ceramics (Professor Toguri);
- corrosion of microelectronic materials (Professor Thorpe);
- fracture of fibre-reinforced ceramics (Professor Weatherly);
- o processing of glass (Professor Barham);
- non-destructive evaluation of ceramics (Professors Argyropoulas and Alcock);
- high-temperature sensor materials (Professors McLean and Sommerville);
- toughened ceramics and ceramic-ceramic composites (Professor Das Gupta);
- In high-strength composites (Prof. Piggott).

Some ceramic research projects are carried out on an interdisciplinary basis in cooperation with various research centres.

Examples include:

- ceramic-metal bonding, in co-operation with the Ontario Centre for Materials Research (Professor North);
- metal hydrides and hydrogen in metals, in co-operation with Centre for Metal Hydride Studies (Profs. Manchester and Weatherly).

For Further Information:

Dr. J. M. Toguri (416) 978-5003 Department of Metallurgy and Materials Science University of Toronto Toronto, Ontario Canada M5S 1A4 Tel.: (416) 978-3013 Telex: 06-218915 UTENTOR 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 1758, 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 hightemperature methods. The structures and properties of the materials are also being investigated.

Dr. H. W. Kerr (Mech. Eng) is studying metal-ceramic joining (with University of Toronto) as a project within the Ontario Centre for Materials Research.

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

For Further Information:

ysics
519) 888-4465
(519) 885-1211,
Ext. 2219
(519) 885-1211,
Ext. 3201
(519) 885-1211,
Ext. 2431
omiatur
(519) 885-1211,
Ext. 4637
chanical Engineering
19) 885-1211.
st. 3470
(519) 885-1211.
Ext 2861

Department of Mechanical Engineering University of Waterloo Waterloo, Ontario Canada N2L 3G1 Telex: 069-55259

University of Windsor

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 ceramic 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:

Dr. H. Yamauchi (519) 973-7050, Ext. 2602 Dr. D. F. Watt (519) 973-7050, Ext. 2600

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

FEDERAL GOVERNMENT ORGANIZATIONS

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Atomic Energy of Canada Limited (AECL) is a federal Crown corporation with a mandate to develop peaceful uses of nuclear energy for the benefit of Canada. It is probably best known throughout the world for the CANDU reactor, as well as for its cancer therapy equipment and radioisotopes.

AECL has over 35 years of experience in technical ceramics, with an excellent mix of ceramic skills and facilities. The current emphasis is on the co-operative development of ceramic products and processes with industrial partners.

Specialization

At its research laboratories in Chalk River, Ontario and Pinawa, Manitoba, AECL specializes in oxide ceramics, glasses and glass ceramics. At Pinawa, various types of oxide ceramics can currently be produced through a continuous process at the rate of 25 Kg per day. AECL two key areas of concentration are:

Ceramic process development

- powder/colloid preparation;
- grinding and granulation;
- o sol-gel processing;
- o forming and firing;
- Roto-Spray calcination;
- glass formulation;
- materials evaluation.

Non-destructive testing (NDT)

- computed tomography;
- neutron diffraction and radiography;
- ultrasonic testing.

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

Products and Services

- chemical and thermal analysis;
- o powder and colloid characterization;
- mechanical testing;
- microstructure evaluation;
- non-destructive testing.

Consulting services include technology audit, materials selection, process/product evaluation and NDT optimization and R&D services, provided on a contract basis, are in the areas of ceramic processing, product development and NDT.

AECL's specialized products include thoria products and NDT instrumentation.

In collaboration with other companies it develops ceramics products and licenses technology.

International Experience

Through its various R&D and marketing activities, AECL maintains close ties abroad and has offices in many countries. Its programs on nuclear and fusion ceramics interact strongly with similar programs in Europe, Japan and the U.S. In recent years, a number of advanced ceramics projects have been completed.

For Further Information:

Mr. B. Palmer Head, Advanced Ceramics Group AECL Chalk River Laboratories Chalk River, Ontario Canada K0J 1J0 Tel.: (613) 584-3311 Fax: (613) 589-2039 Telex: 053-324555

Canada Centre for Mineral and Energy Technology

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 mineralsoriented R&D; the ceramics section is a part of this organization.

Specialization

The R&D 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, ferroelectrics, 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, spraydrying and freeze-drying processes;
- thermophysical properties: automated determination of thermal conductivity, thermal diffusivity and specific heat to 800°C.

Ceramics Section Activities

CANMET's ceramic section is one of the oldest ceramics R&D 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 nine 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 the National Research Council, Departments of National Defence and Regional Industrial Expansion, Communications and Consumer and Corporate Affairs. In future, the section will continue its interaction with the existing and new advanced ceramics companies in Canada.

For Further Information:

Dr. T. A. Wheat Head, Ceramics Section CANMET Department of Energy, Mines and Resources 405 Rochester Street Ottawa, Ontario Canada K1A 0G1 Tel.: (613) 992-1395 Fax: (613) 995-4029

Department of Communications

The Communication Research Centre (CRC) of the Department of Communications is a recognized leader in the research and development of sophisticated communications and signal-processing systems designed to meet the diverse needs of Canadians.

Advanced Ceramics Activities

While a very considerable portion of the R&D at the research centre is devoted to the design and implementation of new electronic systems, some advanced ceramics work is being carried out in the Communication Devices and Components Branch and Space Mechanics Directorate.

Some of the activities are:

 design and fabrication of state-of-the-art, high-frequency microwave, digital and optoelectronic circuits made from III-V semiconductors such as gallium arsenide (GaAs).

The required materials are acquired from commercial sources as well as through cooperation with industry, university and other government agencies. However, extensive facilities including the scanning electron microscope, the X-ray microscope, a photoluminescence scanning system, an Auger microprobe and a broad range of electrical test systems available in-house are used in the R&D programs.

 test and evaluation of advanced composite materials including epoxy, metal and ceramic matrices for strong, light-weight, dimensionally-precise structures for space applications. While the testing and evaluation of these materials are conducted in-house, most materials fabrication and development work is done by Canadian contractors for the CRC.

For Further Information:

Director General Communications Devices and Components Research Branch Communication Research Centre Department of Communications P.O. Box 11490, Station H Ottawa, Ontario Canada K2H 8S2 Tel.: (613) 998-2351

Department of National Defence

The in-house R&D activities of the Department of National Defence are the responsibility of the Defence Research Establishments across Canada. The materialrelated 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 R&D services provided by Canadian industry, universities and provincial research organizations on a contract basis.

Advanced Ceramic 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 co-ordinates 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 firesafety 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-retardent 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.

- The Defence Research Establishment (Pacific) has been researching composites for various defence applications. In addition, DREP is sponsoring development of non-destructive testing techniques for evaluation of advanced structural ceramics including composites. The work is being carried out by Professor P. S. Nicholson at McMaster University.
- The department also supports research and development on piezoelectric ceramic materials at the Royal Military College, Kingston, Ontario.

For Further Information:

Chief Defence Research Establishment (Atlantic) DND P.O. Box 1012 Dartmouth, N.S. Canada B2Y 3Z7 Tel.: (902) 426-3100

Chief

Defence Research Establishment (Pacific) DND Esquimalt, B.C. Canada V0S 1B0 Tel.: (604) 380-2888

National Research Council of Canada

The National Research Council of Canada was established by the Canadian government in 1916 to co-ordinate and promote scientific and industrial research in Canada. Beginning in the 1920s, the council set up in-house laboratories to make available scientific and technical expertise to industry. The NRC laboratory network now extends from coast to coast.

In addition to operating its laboratories, NRC provides financial and technical support for industry through its Industrial Research Assistance Program (IRAP). In recognition of the impact of advanced ceramics as an enabling technology for several Canadian industrial sectors, NRC has instituted a new program for collaborative R&D in Advanced Ceramics. Three areas are being developed: superconducting ceramics, structural ceramics and non-destructive testings (NDT).

The research divisions and laboratories active in advanced ceramics are:

- Chemistry (Ottawa);
- Mechanical Engineering (Ottawa);
- Physics (Ottawa);
- Space Division (Ottawa);
- National Aeronautical Establishment (Ottawa);
- Industrial Materials Research Institute (Boucherville, Quebec);
- Advanced Ceramics Program Coordination Centre, Atlantic Research Laboratory (Halifax, N.S.).

Specialization

Research and development activities in advanced ceramics are carried out in a number of the in-house laboratories of the NRC. R&D is carried out both in functional and structural ceramics.

In functional ceramics the activities are focussed on: semiconducting ceramics; hightemperature super-conductors; zirconia ionic conductors; optical coatings; and piezoelectricpolymer composites.

In structural ceramics, the activities include: process technology; applications in diesel and gas turbine engines; tribology, non-destructive evaluation; reactive plasma synthesis; ceramic fibre synthesis; ceramic-ceramic-metal joining.

Advanced Ceramics Research Program

Recently NRC has implemented a coordinated in-house R&D effort on structural ceramics as part of its program in advanced materials. A group of 28 professionals are involved in various activities related to structural ceramics, including the following:

- monolithic and composite ceramics: process development for SiC, Si₃N₄, and ZrO₂toughened Al₂O₃ ceramics;
- coatings: reactive plasma synthesis, plasma coatings based on TiB₂ in metal matrices;
- non-destructive evaluation (NDE) of monolithic ceramics and composites;
- ceramic-ceramic and ceramic-metal joining;
- development of SiC fibres and coatings from organic polymer precursors;
- prototype testing and evaluation of ceramic diesel engine components;
- hot isostatic pressing and mechanical properties related to gas turbine engine applications;
- tribology.

For Further Information:

Mr. J. R. Wright, Manager Advanced Ceramics Atlantic Research Laboratory National Research Council Canada 1411 Oxford Street Halifax, Nova Scotia Canada B3H 3Z1 Tel.: (902) 426-5297 or 426-8332 . .

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PROVINCIAL RESEARCH ORGANIZATIONS

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The Alberta Research Council (ARC), started in 1921, is a provincial Crown corporation with a mandate to support and promote economic development in Alberta through scientific, engineering and technological research. It is the oldest and largest provincial research organization, with a staff of about 500 scientists, engineers and support staff. Administrative offices are in Edmonton, with other facilities in Calgary, Devon, Nisku, Red Deer and Lethbridge.

Four research divisions are responsible for programs covering fundamental and applied research, engineering and testing and the operation of specialized information centres. The council also enters into contract research and joint research agreements with industry and government, with emphasis on technology transfer.

Specialization

The Alberta Research Council is expanding its capabilities and expertise to perform and sponsor research and development in advanced industrial materials and, in particular, advanced ceramics. Emphasis has been placed on the development of plasma technology for the application of wear, abrasion and corrosion-resistant advanced ceramic coatings.

Advanced Ceramic Activities

ARC has been involved in materials research for some time, and has well-equipped metallographical, polymer and forest products testing facilities. However, programs in advanced ceramics are being expanded to provide assistance to industry through contract R&D and jointly-funded projects. It is recognized that advanced ceramics will play a very important role in many industrial sectors of Alberta's economy including the oil and gas industry, agriculture, the medical field, electronics and telecommunications.

International Experience

Although the emphasis is on co-operation with Alberta industry, the Alberta Research Council is a partner of numerous R&D ventures in several countries, particularly the U.S.

For Further Information:

Dr. Robert B. Heimann Manager, Materials Section Industrial Technologies Department Alberta Research Council P.O. Box 8330, Postal Station F Edmonton, Alberta Canada T6H 5X2 Tel.: (403) 450-5111 Telex: 037-2147 Fax: (403) 461-2651

Industrial Technology Centre Division of the Manitoba Research Council

The Industrial Technology Centre (ITC) was established by the Manitoba Research Council as a product development and testing facility to serve Manitoba industry. The centre 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 ITC 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.

The Centre 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

The Industrial Technology Centre provides specialized services in:

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

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

Services

Specific services provided by the Industrial Technology Centre are:

- electronic circuit design, computer-based systems design, communication systems design, product selection, testing and evaluation;
- mechanical design and analysis (solid modelling, finite element (FE) analysis, modal 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

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

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

International Experience

The Industrial Technology Centre 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:

Mr. L. P. Haberman Director Industrial Technology Centre 1329 Niakwa Road Winnipeg, Manitoba Canada R2J 3T4 Tel.: (204) 945-6000 Fax: (204) 945-1784 Telex: 07-587833 The Nova Scotia Research Foundation (NSRF) was established in 1946 by the Province of Nova Scotia to use science and technology in assisting the economic development of the province.

Three operating departments - Applied Science, Industry Services and Product Development - carry out technical assignments for about 600 companies and government departments each year.

A wholly-owned subsidiary, Nova Magnetics Limited, designs, manufactures and markets magnetically-coupled zero-leakage blowers and pumps for the nuclear and chemical industry.

Specialization

The foundation pursues two main goals - to assist industry in solving today's technical problems and creating innovative products and processes in anticipation of tomorrow's opportunities. While the foundation 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 ocean industry.

Materials technology activities include: R&D in ceramics; mechanical and metallurgical testing; welding procedure qualification; failure analysis; and corrosion studies.

Services

The foundation offers a wide range of services in the following areas:

- analytical and environmental chemistry;
- o biology/microbiology;
- o coal technology;
- o land and marine geophysics;
- technical information/literature searches;
- technology transfer/acquisition;

- technical/market analysis;
- fisheries engineering;
- materials testing;
- product development engineering;
- © ceramics research and development.

Advanced Ceramics Activities

Ceramic research and development work at NSRF was initiated in 1981 in co-operation with the Atlantic Research Laboratory of the National Research Council. To date, work has been 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 sucessfully 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.

Present activities include the development of advanced ceramic composites based on alumina-zirconia systems, particularly process-related technologies including sol-gel techniques for the preparation of powders and pressure casting.

International Experience

NSRF exports specialized equipment for the ocean industry throughout the world.

For Further Information:

Mr. R. F. MacNeill Vice President Nova Scotia Research Foundation P.O. Box 790 Dartmouth, Nova Scotia Canada B2Y 3Z7 Tel.: (902) 424-8670 Fax: (902) 465-7384 Telex: 019-22719

Ortech International (Formerly The Ontario Research Foundation)

Ortech International is a comprehensive technology consulting enterprise serving commercial organizations and government. It helps businesses to adapt innovative approaches to product and process development, and helps to improve productivity, product and competitiveness. Ortech serves more than 2000 clients annually.

A portfolio style of management prevails, with nine business centre managers reporting to two division heads. Areas covered include problem solving, testing, research and product development. Expertise in many fields and specialized equipment are available.

Ortech is unique in that business and technical viewpoints can be applied simultaneously to client's needs. Management is able to take a multi-disciplinary approach, combining the skills resident in different areas to form project teams.

Specialization

Ortech provides R&D and specialized services on a contract basis in glass and ceramics studies. It has established its expertise over three decades to become one of the leading organizations in this area in Canada. Specialization includes:

- ◎ fine powder preparation and processing
- sol-gel technology;
- forming and sintering;
- coating technologies (including plasma);
- prototype development;
- materials characterization;
- mechanical and thermal property measurement;
- composite preparation technology;
- optical fibre production technology;
- glass and ceramic-to-metal sealing;
- piezoelectric and ferroelectric ceramics;

materials processing in micro-gravity.

Services

Ortech provides the following services:

- process/product development: the foundation provides technology research in processes and fabrication to increase product markets and carries out preproduction feasibility studies to eliminate problems;
- problem solving and testing: the foundation project teams investigate the cause of problems with assistance of a wide range of state-of-the-art equipment;
- systems consulting: available to both the public and private sector, the consultation process involves feasibility studies, technology assessments, equipment selection, evaluation and pilot-production studies;
- technology transfer: the foundation facilitates transfer of new developments from public or private laboratories 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. This allows the company to apply a global perspective to its information programs and consulting projects.

For Further Information:

Dr. Ivan H. Joyce, Manager Glass and Ceramics Centre Ortech International Sheridan Park Research Community Mississauga, Ontario Canada L5K 1B3 Tel: (416) 822-4111 Fax: (416) 823-1446 Telex: 06-982311 INDUSTRIAL ASSOCIATIONS

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Advanced Materials Engineering Centre (AMEC)

AMEC is a not-for-profit Nova Scotia organization supported by a consortium of founding members and by grants from the Canadian Government with financial assistance from the Government of Nova Scotia. The co-founding members are the Grumman Corporation of New York, General Composite Technology of Nova Scotia and the Technical University of Nova Scotia (TUNS).

AMEC, which is located in Halifax, is being established as a centre with experience and capability in the fields of advanced materials, structures and coatings, with special emphasis on early commercialization of the advanced technologies.

AMEC will provide the means for transition of advanced materials technology from research and development into commercialization by providing design and production engineering services, state-of-theart manufacturing and testing equipment and training programs to its members and customers. Membership will be available to all organizations which have need for the technologies available.

The major source of revenue is expected to come from industrial and government-funded development programs.

AMEC will commence operations late 1988 and is expected to be fully operational by the end of 1989 when almost \$5 million of equipment will be in place.

Specialization

The goal of AMEC is to become an internationally recognized development centre in materials design and production.

The Centre will provide this expertise to defence and commercial enterprises interested in the development and application of advanced materials.

Services

AMEC will be able to provide:

- Co-operation development programs;
- Production engineering services;
- Industrial training/education services;
- Information diffusion network.

The Centre will provide the engineering capabilities as well as associated commercialization, marketing, training and support services.

Advanced Ceramic Research Programs

Initial emphasis will be placed on the development of high temperature ceramic coatings for protection of metal parts against oxidation, erosion and corrosion and polymer matrix composite structures for aerospace, marine and commercial applications.

For Further Information:

Mr. Richard Hadcock, President AMEC P.O. Box 1618, Station M Halifax, Nova Scotia Canada B3J 2Y3 Tel.: (902) 425-4500 Fax: (902) 422-7907

Advanced Materials Technology Unit

The Advanced Materials Technology Unit (AMTU) is located on the Queen's University campus in Kingston, Ontario. Its activities are supported by its industrial members. The AMTU Board of Directors is selected from its sustaining members.

The major objective of the AMTU is to promote, stimulate and enhance universityindustry collaboration in all matters relating to advanced materials technology. AMTU, with representation from the departments of Metallurgical, Chemical, Mechanical and Electrical Engineering, Physics, Chemistry, Geology and School of Business, provides industrial affiliates with access to departmental expertise, equipment and analytical techniques within the university. The synergism among the participating departments provides an inter-disciplinary approach to many of the projects tackled. AMTU also provides access to the main and branch libraries of the university.

Another of its activities is to organize theme conferences and evening seminars on topics relevant to its affiliates.

Advanced Ceramics Activities

AMTU believes that the needs of industry are better served if the advantages of using advanced ceramics are put in the context of other competing materials such as composites, advanced metals and polymers. To this end, AMTU tries to provide a broad perspective in the development and use of advanced ceramics.

Membership

The following companies are members of AMTU:

Name	Type of Membership
Alcan International Ltd.	Sustaining
Dupont of Canada Inc.	Sustaining
Falconbridge Ltd.	Sustaining
Polysar Ltd	Sustaining
Algoma Steel Corporatio	n Ltd. General
Almax Industries Ltd.	General
Murata Erie North Ame	rica Ltd. General
Ontario Hydro	General
3 M Canada Ltd.	General
B.M. Hi-Tech Inc.	Small Business
Canadian Plastics Institu	te Small Business
EYC Industries Limited	Small Business
Fahrmet Steel Castings	Small Business
Kenrock Tools Ltd.	Small Business
Ceramics Kingston Inc.	Small Business

For Further Information:

Dr. J. Cameron Co-ordinator, AMTU Queen's University Kingston, Ontario Canada K7L 3N6 Tel.: (613) 545-2755

Canadian Advanced Industrial Materials Forum

The Canadian Advanced Industrial Materials Forum (CAIMAF) is now being established under the sponsorship of the Canadian Manufacturers Association. The concept of the forum was developed by a group from industry, government and universities to ensure that Canadian industry could meet the demand for new materials and control their impact on the Canadian resource and manufacturing sectors.

The objectives of CAIMAF are:

- to provide a national focus for Advanced Industrial Materials (AIM) and, thereby,
- to promote competitive development and use of AIM in all reasonable, lawful and proper ways;
- to ensure strong, long-term linkages and communications between users, suppliers, designers, manufacturers and researchers related to AIM;
- to provide a forum for the exchange of legally exchangeable information on all subjects of common interest to members;
- to collect, analyse and distribute design, performance, technical, statistical and other information related to AIM;
- to make representation to government and other bodies on questions of common interest to the members with respect to AIM.

Two types of activities of CAIMAF have been identified. The core activities, to start in 1988, comprise:

- a newsletter (bi-monthly);
- a directory;
- an advisory service;
- © seminars/workshops (quarterly).

The optional activities, to be implemented at a later date, comprise:

- an automated information service;
- a materials audit service;
- experimental seminars.

Membership

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

The current membership is 50.

For Further Information:

Mr. Richard E. Glinski
Executive Director
Canadian Advanced Industrial Materials Forum
One Yonge Street
14th Floor
Toronto, Ontario
Canada M5E 1J9
Tel.: (416) 363-7261
FAX: (416) 363-3779

Canadian Ceramic Society

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 intimate 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 five divisions: Structural Clay and Refractories; Enamels; Pottery and Whitewares; Glass; Electronics and Basic Science.

Besides the annual convention, the society sponsors general meetings throughout the year, the most notable being the fall meetings. The technical program at the annual convention comprises all the divisions. However, the fall meetings of the divisions, held separately, reflect the interests of the division members.

Membership 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 Canadian Clay and Ceramics magazine, published bi-monthly, is the official organ of the society. The Journal of the Canadian Ceramic Society, published annually, consists of scientific and technical papers presented at the annual convention, as well as those submitted to the society for publication. Both magazine and journal are 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:

Mr. Len L. Taylor Administrator Canadian Ceramic Society 2175 Sheppard Avenue East Suite 110 Willowdale, Ontario Canada M2J 1W8 Tel.: (416) 491-2886

Canadian University-Industry Council on Advanced Ceramics

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. Current membership: eight university, 43 industrial and one government agency.

Workshops, Seminars and Publications

CUICAC organizes three workshops every year, one of them in conjunction with the annual general meeting usually held in February. 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 nonmembers 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 co-operation agreement with the Japan Fine Ceramics Association.

For Further Information:

Dr. P. S. Nicholson President, CUICAC McMaster University, JHE 249 Hamilton, Ontario Canada L8S 4L7 Tel.: (416) 529-7575 FAX: (416) 529-5994

Ontario Centre for Materials Research

The Ontario Centre for Materials Research (OCMR) is one of the seven Centres of Excellence set up by the Ontario provincial government in June 1987. With enabling funds from the provincial government, the Centre has been created to perform worldclass 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; Waterloo University; and University of Western Ontario, London. All the research programs sponsored by OCMR will be carried out in these institutions.

The initial industrial support for the creation of OCMR has come from about 40 companies. Detailed management structure, fees, classes of membership and other pertinent details are expected to be established in the near future.

Advanced Ceramics Activities

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

- biomaterials;
- microstructural optimization;
- polymers and composites;
- optoelectronic materials;
- interface science and technology.

Glass and ceramic materials research pertains in all five areas; however, specific programs on glasses and 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 microstructural optimization theme.

OCMR plans to supplement the provincial government grants with contractual research projects with industry. Information dissemination is to be achieved through workshops, seminars and advanced educational courses.

For Further Information:

Dr. J. P. McGeer, Managing Director Ontario Centre for Materials Research P.O. Box 1146 Kingston, Ontario Canada K7L 4Y5 Tel.: (613) 389-3687

ACTIVITY INDEX

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(*) Federal Government Laboratories/Provincial Research Organizations/Crown Corporations

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UNIVERSITY

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(*) Federal Government Laboratories/Provincial Research Organizations/Crown Corporations

	INDUSTRY	UNIVERSITY	OTHERS (*)
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(*) Federal Government Laboratories/Provincial Research Organizations/Crown Corporations

	INDUSTRY	UNIVERSITY	OTHERS (*)
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ž	32		
Zircon	13,16		
Zirconia	11,12,16		60,63,69
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(*) Federal Government Laboratories/Provincial Research Organizations/Crown Corporations

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PRODUCT INDEX

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Cordierite	13
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Laser glasses	5,43
Magnesia	16,33
Magnetics	26
Mullite	13
Nuclear ceramic	59
Optoelectronics	8
Oxide crystals	8
Piezoelectrics	4,5,20,49,50,56,60,70
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> Information gathered and compiled by: MKM Consultants International

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