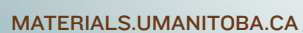


MANITOBA INSTITUTE FOR MATERIALS



**MANITOBA INSTITUTE
FOR MATERIALS**

121 Machray Hall, Fort Gary Campus
University of Manitoba
Winnipeg, MB R3T 2N2
Canada

T 204.474.7820

F 204.474.7384

materials.umanitoba.ca

STAFF

Director

Dr. Michael Freund

Operations Coordinator

Jennifer Low

***Electron Spectroscopy and
Microscopy Facility Manager***

Dr. Abdul Khan

***Materials Characterization and
Spectroscopy Facility Manager***

Dr. Kevin McEleney



MIM

The **Manitoba Institute for Materials** facilitates and enhances basic and applied materials science at the University of Manitoba and in the prairie region. There are a large number of materials researchers in the region who are actively pursuing fundamental and applied research of complex materials. The Institute provides mechanisms to foster networking and collaboration between researchers with different backgrounds and from diverse disciplines, as well as maintain, build, and enhance the research capabilities of the region's materials scientists. The Institute also supports the research and training environment within the university by organizing an annual research conference and by bringing in visiting scientists for discussions, seminars, and longer-term stays. Finally, the Institute provides a platform for leveraging grant applications of members for equipment and personnel to enhance the research capacity in the region.

If you are a researcher in the prairie region who is interested in getting involved with the Institute or an organization interested in accessing our expertise and infrastructure, please do not hesitate to contact us.

RESEARCH

COMPLEX NATURAL SYSTEMS

The world is changing rapidly. Increasing demands for energy, minerals, and food is putting pressure on natural systems as human population rises. Sustainability will be about our ability to measure the effects of supplying our way of life and balancing this with our effects on the planet. Many environmental and industrial processes are traceable using isotopes, isotopic ratios and trace elements, we can use chemical and structural information from natural materials like, minerals, soil and water to help minimize our environmental impact as well as maximize the efficiency of our industrial activities.

RESEARCH STRENGTHS: *Use of isotopes and trace elements to monitor exchanges between the Earth's crust, the hydrosphere and the biosphere; characterization and quantification of the distribution of trace elements in zoned minerals; crystal chemistry and structural crystallography; the use of isotope and trace element fractionation to understand ore genesis and contaminant dispersal.*

COMPOSITE MATERIAL SYSTEMS

The need to develop light but strong materials to improve both fuel efficiencies in transportation and the performance of engineering structures explicitly requires a good foundation in materials science research. The university is home to success stories involving the application of this science, such as the Composites Innovation Centre (CIC) and the ISIS Canada Research Network. Continued innovation in composites, including those developed from biological materials, will require sound fundamental research to understand the role of structure and bonding at various length scales in dictating the limits of performance as density is decreased. A key question in the adoption of composites from renewable resources is: What processing strategies can be devised to compensate for deficiencies in raw material properties (due to natural variability) so that performance targets for bio-composites can be consistently met?

RESEARCH STRENGTHS: *Aerospace composite materials; fiber reinforced polymer materials; fabrics; composites generated from biological materials; oil seed resins; "breathable" and "smart" textiles; and wound dressings.*

CRYSTALLINE MATERIALS AND NANOSTRUCTURES

From prescription drugs, to cookware, to computer chips, many materials that are used every day are made of crystals that possess special properties. The properties of any material are largely determined by how its atoms are arranged. For crystalline materials, the atomic arrangement — as well as the arrangement of crystals themselves — are basic to their physical behaviour. Many modern synthetic materials have intentionally tailored atomic or crystal arrangements. Knowing how atoms are arranged in new compounds is fundamental to understanding how to tailor materials chemically and physically to get the desired properties (for use in new electronic devices, for example). This interdisciplinary thrust area brings together researchers who want to understand the fundamental behaviour of technologically important materials, such as catalysts, ionic conductors, superconductors, alloys, ceramics, cements, magnets, and radioactive waste forms.

RESEARCH STRENGTHS: *Magnetic, electronic and transport properties of materials; nanostructures; superalloys; complex minerals; and phononic crystals.*

HIGH PERFORMANCE COMPUTING (HPC)

The rapid advances of massively parallel computing, coupled with equally impressive developments in theoretical analysis, have generated an extraordinary growth in our ability to model and predict the behaviour of materials and to visualize the results. Computational science is entering a new era that promises to revolutionize our understanding of materials, expanding our knowledge beyond that of idealized systems to touch the real materials that enrich our lives. HPC embraces all aspects of equipment, people, data, software, and access capabilities. It is essential to the needs of researchers in all disciplines. HPC facilities provide researchers with opportunities for inter-institutional and multi-disciplinary collaboration, facilitating research and innovation that would otherwise be impossible.

RESEARCH STRENGTHS: *Computational chemistry, physics, fluid dynamics, and electromagnetics; magnetic materials; biomaterials; spintronics; polymers; soft matter; composite materials; and microwave imaging.*





MICROELECTROMECHANICAL SYSTEMS

Nanosystems technologies (NSTs) are enabling the construction of complex systems that possess the benefits of high integration of multi-disciplinary technologies and small size. These include microelectronics, microfluidics, microelectromechanical systems (MEMS), nanoelectromechanical systems (NEMS), and photonics. Several technologies are often combined on a single nanosystem, enabling the production of powerful devices. Microsystem technologies are greatly impacting our lives. In the coming decades, the influence of NSTs will be on par with that obtained by microelectronics over the last 30 years. As a result, governments worldwide have identified nanotechnology as a strategic area.

RESEARCH STRENGTHS: *Next generation smart adaptive antennas for vehicle systems and telecommunications; nano-probe instruments for in-situ integrated circuit testing, and material science; molecular junctions; micro-sensors for electric and magnetic fields; sensors for structural health monitoring for civil engineering; micro-pressure sensors for human hearing studies; microfluidics for thermal cooling, energy storage, and bio-sensors; ultra-thin films for nanoelectronics and bio-sensors; large deflection micro-mirrors for optical switching; microresonators; and BioMEMS.*

PHOTONIC AND PHONONIC INTERACTIONS WITH MATERIALS

The interaction of photons and phonons with matter allows materials to be probed over a wide range of length and time scales, providing vital information for understanding their basic properties. Phonons are also one of the elementary excitations of materials, so their interaction with other excitations (such as electrons and magnetic moments) is also of fundamental importance. This multidisciplinary research area involves material properties that include: single atoms and molecules (excitation, ionization, probing, manipulation); complex molecular systems (biological, pharmaceutical, chemical — including distributed optical fibre sensing); nanostructures (quantum dots, nanofabrication, nanomachines, surface structures); microscopic interactions (optical tweezers, cell interactions, linear and non-linear photoacoustic interactions); and millimetre and larger scale systems (ultrasonic and acoustic interactions in mesoscopic materials).

RESEARCH STRENGTHS: *Imaging of complex materials; scattering and absorption in complex materials; surface acoustic wave devices; X-ray scattering and diffraction; NMR and Mössbauer spectroscopies; and photon and phonon correlation spectroscopies.*

SOFT AND DISORDERED MATERIALS, LIQUID AND SOLID CRYSTALS

The study of soft materials such as complex fluids, macromolecules, particulate suspensions, porous materials, foodstuffs, and biological materials — is a rapidly growing area that encompasses both new scientific discoveries and diverse practical applications. Many of these materials are mesoscopic, having internal structures on length scales between atomic dimensions, and bulk that determine their properties. There is a natural synergy with disordered hard materials, whether disorder is inherent at the atomic scale as in crystalline solids, glasses, and complex minerals, or at larger scales as in assemblies of nanoparticles. The study of solid materials underlies much current and emerging technology involving optical, electronic, and spintronic phenomena.

RESEARCH STRENGTHS: *Glasses; nanoparticles and spin glasses; polymer and biomaterials; mesoscopic materials; materials for nuclear waste immobilization; optical, electronic, and spintronic properties of ionic and semiconducting crystals; complex minerals; protein structure; tissue and cellular structure; viral architectures; and textiles.*

SURFACES, INTERFACES AND ULTRA-THIN FILMS

The performance of many of the key materials that play a critical role in today's technology are dominated by the structure and chemistry of their interfaces. The properties of these interfaces are controlled by layers that can be as little as a few atoms or molecules thick. Our ability to understand the physics and chemistry of interfaces and, in turn, manipulate their properties will ultimately determine the direction of future developments in fields ranging from biotechnology to electronics. This interdisciplinary area will bring together researchers focused on the characterization and production of interfaces, both within materials as well as at surfaces, and it will stimulate development of the understanding and methodologies required to create the next generation of advanced materials and devices.

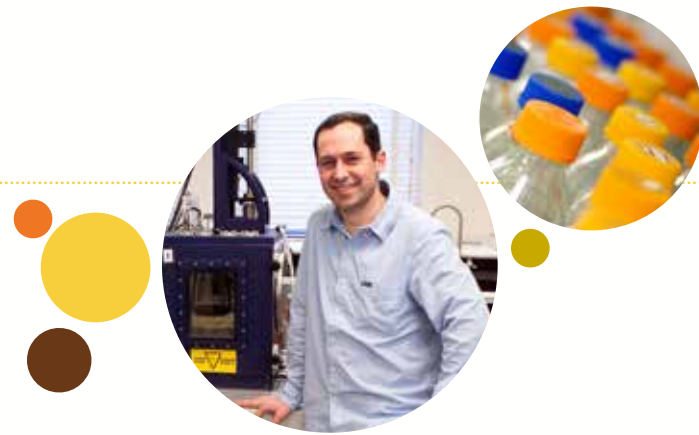
RESEARCH STRENGTHS: *Electronic and magnetic materials; polymer structures; superalloys; and environmental crystallization.*

PEOPLE

The Institute membership spans four faculties and eight departments and includes over 50 research-active professors supervising approximately 20 postdoctoral scholars, 50 PhD, and 60 MSc students. These researchers attract an average of \$5 million annually in research support, and produce over 100 academic publications per year in leading international journals.

The membership has demonstrated the ability to respond to priority areas by assembling highly effective collaborations addressing fundamental and applied research areas including: aerospace, composites, polymers, mineralogy, high performance materials, corrosion, surface science, and electronics.

materials.umanitoba.ca/people

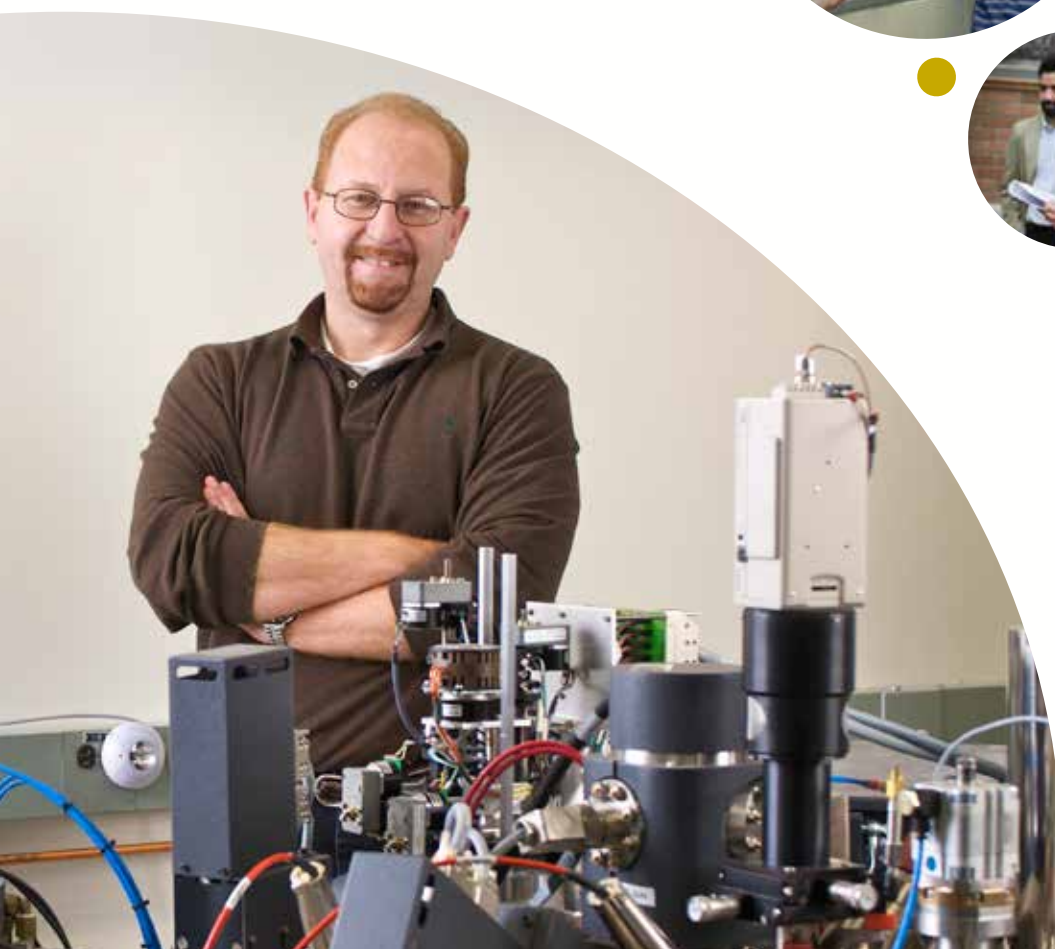


OUTREACH

The Institute actively develops undergraduate and graduate curricula ensuring that trainees are exposed to cutting-edge techniques and approaches. Trainees have access to specialized equipment that is unique within the region which enhances their learning outcomes and the transfer of skills to industry upon graduation. The Institute is also involved in high school outreach giving an overview of current topics in materials science, and hands-on research experience.

TRAINING

Institute members provide workshops and training for industry and researchers in a variety of characterization techniques.



*Secondary Ion Mass Spectrometry Laboratory,
Clayton H. Riddell
Faculty of Environment,
Earth, and Resources.*



INFRASTRUCTURE

IMAGING

- Optical microscopy
- Scanning electron microscopy
- Transmission electron microscopy
- Scanning probe microscopy
- Infrared and Raman spectroscopy
- X-ray photoelectron and Auger spectroscopy
- Secondary ion mass spectrometry

ELEMENTAL ANALYSIS

- Mössbauer spectroscopy
- Energy and wavelength-dispersive X-ray spectroscopy
- X-ray photoelectron and Auger spectroscopy
- Secondary ion mass spectrometry
- Laser-ablation inductively coupled plasma mass spectrometry
- Inductively coupled plasma optical emission spectroscopy

CHEMICAL IDENTIFICATION

- Ultraviolet-visible-near infrared spectroscopy
- Infrared and Raman spectroscopy
- Gas chromatography and liquid chromatography mass spectrometry
- Liquid and solid-state nuclear magnetic resonance spectroscopy
- X-ray photoelectron spectroscopy

THIN FILM & NANOPARTICLE CHARACTERIZATION

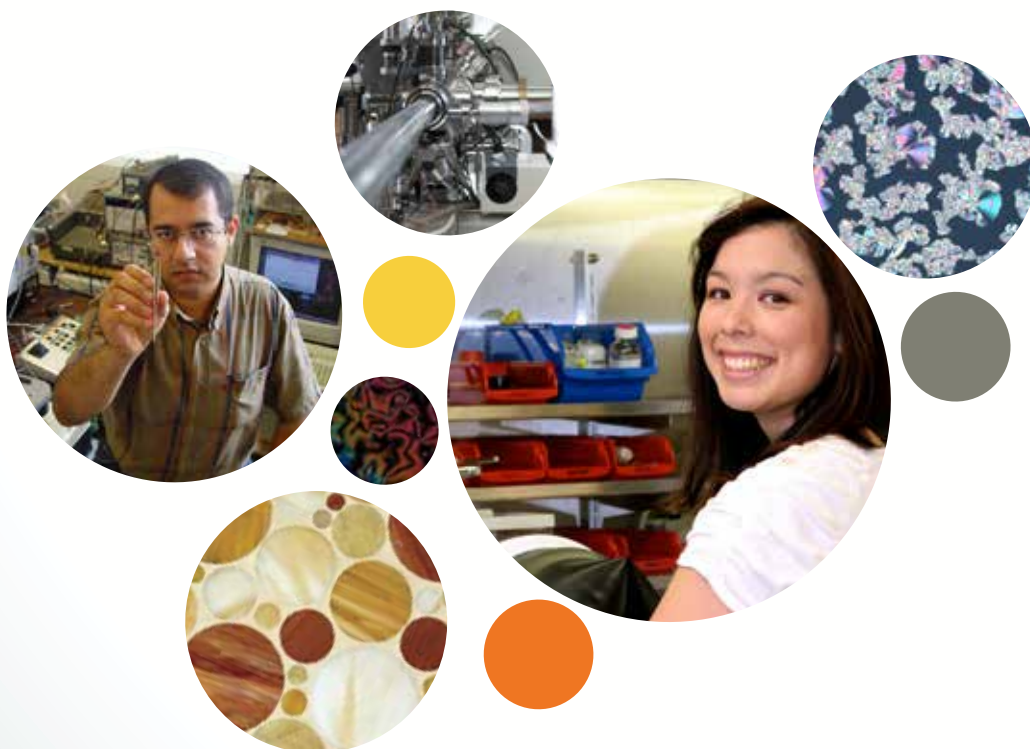
- Ellipsometry, profilometry and interferometry
- X-ray photoelectron and Auger spectroscopy
- Polarization modulated infrared reflection absorption spectrometry
- Dynamic light scattering
- Small and wide angle X-ray scattering

STRUCTURAL INFORMATION

- Single crystal and powder X-ray diffractometers
- Small and wide angle X-ray scattering
- Ultrasonic spectrometers
- Nuclear magnetic resonance spectroscopy

BULK PROPERTIES

- Differential scanning calorimeters and thermal gravimetric analyzers
- Magnetometers
- Conductivity



EXPERTISE

The Institute is comprised of more than 50 academic researchers and 10 highly trained technicians with considerable expertise in a wide range of sophisticated instrumental techniques. In combination with highly trained graduate students and postdoctoral researchers, this expertise is used to investigate fundamental and applied areas essential to industry, the environment, and energy. Members of the Institute have a tradition of assembling collaborative and interdisciplinary teams to address complex R&D issues.

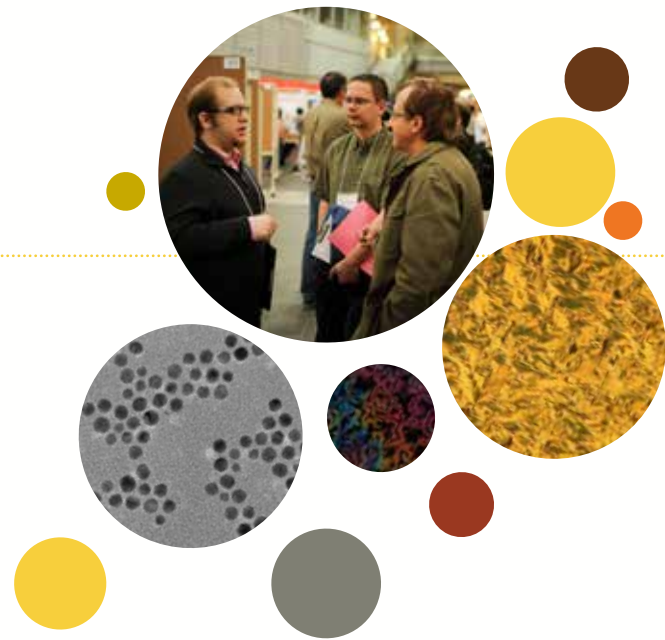


*Nano-Systems
Fabrication Laboratory,
Faculty of Engineering*

CONFERENCE

The Manitoba Materials Conference is an annual event highlighting undergraduate student, graduate student, postdoctoral, and other academic research in fields related to materials science and technology in the region. Research areas highlighted include:

- Crystalline materials and nano-structures
- Composite material systems
- High performance computing
- High temperature aerospace materials
- Microelectrical mechanical systems (MEMS)
- Photonic and phononic interactions with materials
- Soft and disordered materials
- Surfaces and interfaces
- Complex natural systems



*2012 Manitoba Materials
Conference participants*



OUR SUPPORTERS

The Institute is a portal for access to the University's considerable expertise in materials research and characterization. We actively facilitate the development of sponsored research projects, partnerships, and training. Members of the Institute are available to consult as well as develop research contracts.

MIM and its members have received funding support from Western Economic Diversification, Canadian Microelectronics Corporation, the Natural Sciences and Engineering Research Council of Canada, the Canada Foundation for Innovation, the Canada Research Chair program, and the Province of Manitoba Research and Innovation Fund.

Collaborators and supporters locally include The University of Winnipeg, the Institute for Bidiagnostics, and the Concordia Hip and Knee Institute.



**MANITOBA INSTITUTE
FOR MATERIALS**

121 Machray Hall, Fort Gary Campus
University of Manitoba
Winnipeg, MB R3T 2N2
Canada

T 204.474.7820

F 204.474.7384

materials.umanitoba.ca

STAFF

Director

Dr. Michael Freund

Operations Coordinator

Jennifer Low

*Electron Spectroscopy and
Microscopy Facility Manager*

Dr. Abdul Khan

*Materials Characterization and
Spectroscopy Facility Manager*

Dr. Kevin McEleney



UNIVERSITY
OF MANITOBA