

# Catalyzing Tomorrow's Materials Innovations

CANADIAN CENTRE FOR ELECTRON MICROSCOPY STRATEGIC PLAN 2021-2026

**BREAKTHROUGH  
MATERIALS  
RESEARCH**



**LEADING IN  
EDUCATION AND  
TRAINING**



**PROVIDING  
SPECIALIZED  
SERVICES**



# Catalyzing Tomorrow's Materials Innovations

CANADIAN CENTRE FOR ELECTRON MICROSCOPY STRATEGIC PLAN: APRIL 1, 2021-APRIL 30, 2026

This strategic plan outlines the direction CCEM will take in the next 5 years to maintain and expand its role as a national enabler of breakthrough materials research, a global leader in electron microscopy (EM) education and training, and a provider of accessible specialized EM services. We will strengthen our connectivity by leveraging national and international partnerships and networks with leading organizations in materials research. We will enhance our capabilities and capacity in the delivery of our EM research, training, and services. Using best management practices, our best-in-class instrumentation, and our diverse team of expert scientists, we will contribute to the scale and scope of materials innovations that are important to the prosperity, health and security of Canadians.

## About Us

### CANADIAN CENTRE FOR ELECTRON MICROSCOPY

The Canadian Centre for Electron Microscopy (CCEM) is located at McMaster University and was opened in 2004. Since 2014, CCEM is funded by the Major Science Initiatives (MSI) program as one of 17 national research facilities in Canada. CCEM houses best-in-class electron and ion microscopes; a team of 13 full-time professional expert staff operate the facility, perform microscopy services, and train users. CCEM has a diverse, national user base of more than 500 users annually. The research published by CCEM users has steadily grown to more than 140 peer-reviewed journal articles annually. CCEM serves users from academia and industry, from all over Canada and internationally. The research projects range from biology to chemistry, geology, and engineering.

Building on our past success and reputation, this 5-year strategic plan outlines our ambitious vision to make CCEM a sustainable, accessible, and excellent research facility for the benefit of Canadian science, commercial enterprises and society in general. Our goal is to enable our users and partners to solve tomorrow's material problems for a brighter world.

## Fast Facts



500+

- Over 500 users annually

140



- More than 140 peer-reviewed journal articles annually



900+

- More than 900 webinar attendees

13



- 13 staff members

Fifteen



- 15 major instruments

# Drivers, Vision, Value Proposition

CANADIAN CENTRE FOR ELECTRON MICROSCOPY STRATEGIC PLAN: APRIL 1, 2021-APRIL 30, 2026

## DRIVERS

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- New and improved materials are essential building blocks for a more prosperous, cleaner, and healthier tomorrow. In turn, cutting-edge micro-and nanoscale materials characterization is a critical enabler to unlocking breakthrough materials innovations.
- An increase in the scale and pace of materials innovation in Canada depends on effective national connectivity among researchers and innovators in the materials applications, materials development, and materials characterization domains.
- The intersection of the COVID-19 pandemic and the demands for equality and opportunity for all are accelerating society towards a “new normal”, where successful organizations will be those that embrace inclusiveness, collaboration, and innovative delivery of services.
- National research facilities funded by the Canada Foundation for Innovation’s (CFI) MSI are expected to support leading-edge research and technology development, contribute to talent development, and promote the mobilization of knowledge and transfer of technology to society through shared access by a pan-Canadian user community to specialized equipment, services, resources, and scientific/technical personnel.

## VISION

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Through our EM research, training and services, we catalyze tomorrow’s materials innovations.

## VALUE PROPOSITION

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### BREAKTHROUGH MATERIALS RESEARCH



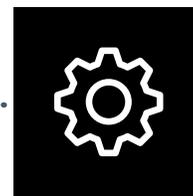
CCEM is a national enabler of breakthrough materials research. CCEM pushes forward the boundaries of materials characterization to inform and enable partners’ materials innovations that are strategically important to Canada and the world.

### LEADING IN EDUCATION AND TRAINING



CCEM is a global leader in EM education and training. CCEM provides national leadership in developing the next generation of EM experts.

### PROVIDING SPECIALIZED SERVICES



CCEM is a provider of specialized EM services. CCEM offers wide-ranging, accessible, best-in-class electron and ion microscopy solutions for the challenging problems of the Canadian and international scientific and technological communities.

# Strategic Goals

1

We will push the cutting-edge of materials characterization that

best enables strategically important materials breakthroughs.

1. **Achieve international leadership in EM application and technique development.**

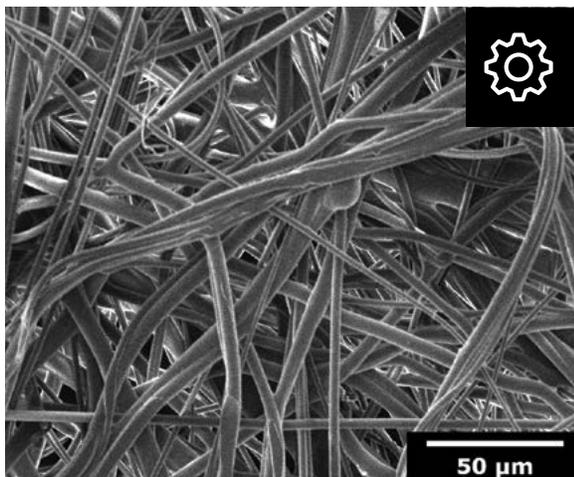
Through our Scientific Director/Associate Scientific Directors network, our embedded researchers, and our professional staff, we will engage in collaborative projects with international EM leaders that push the frontiers of EM techniques.

2. **Ever-green our facilities.**

We will pursue opportunities to ever-green our EM equipment and facilities to remain internationally recognized for excellence.

3. **Invest in our people.**

Through our focus on recruitment and professional development of our CCEM experts, we will be recognized as an international Centre of Excellence (CoE) and high-value partner.



2

We will expand national connectivity to researchers and innovators in materials characterization,

development and applications to accelerate the pace and scale of materials innovations.

1. **Build correlative and complementary characterization capabilities.**

We will create mutually beneficial arrangements with colleague CoEs to make seamless correlative characterization capabilities accessible to Canada's materials researchers and innovators.

2. **Facilitate regional access to EM instrumentation.**

We will collaborate with colleague EM facilities to help ensure Canadian EM user communities have timely access to the EM instrumentation they need.

3. **Promote the collaborative pursuit of ideas and projects.**

We will take a leadership role in the development of grant proposals built on the best ideas emerging across the national and international material and biological science community and will provide project management services to help ensure project success.

4. **Connect with commercialization support organizations.**

We will establish business relationships with public and private sector organizations that offer business support services and financing to help start-ups and small- and medium-sized enterprises (SMEs) bring their materials innovations to market.



PROVIDING  
SPECIALIZED SERVICES

*Scanning electron microscope (SEM) images of mask materials enabled Vitacore Industries to be the first Canadian personal protective equipment (PPE) and respirator manufacturer authorized by Health Canada.*

# Strategic Goals

3

We will re-imagine CCEM's business model to drive impact, inclusiveness, and innovation.

1. **Grow our intellectual capacity.**

We will expand our national network of Associate Scientific Directors and will increase research depth with embedded researchers.

2. **Transition from data-centric to secure knowledge-centric projects.**

We will grow our capabilities to translate our partners' datasets into knowledge and solutions through custom-tailored consulting, expanded data acquisition, and processing services, thus improving research context and impact.

3. **Expand our virtual environment.**

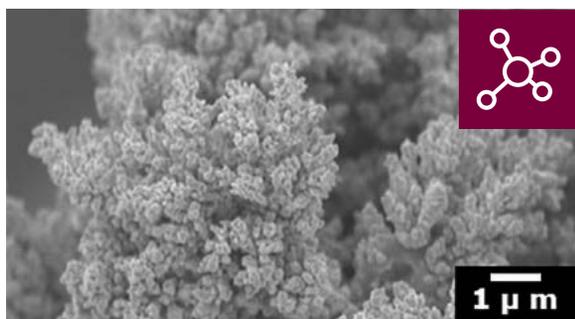
We will expand our ability to engage researchers and clients from across Canada and internationally through virtual access to our facilities and services.

4. **Increase our accessibility.**

Through re-imagined mutual partnership arrangements, we will increase accessibility to our facilities and services tailored to the specific needs of our partners, collaborators, customers, students, and users.

5. **Lead in health, safety, and equity, diversity and inclusiveness for all.**

We will promote a culture of openness, transparency, and dialogue and will build an environment that overcomes systemic barriers for all whom we engage.



4

We will be Canada's leader in education and training of the next generation of electron microscopists.

1. **Create the CCEM Academy.**

We will develop best-in-class online and in-person education and training in partnership with colleague national and international EM CoEs that can be integrated into the educational offerings of academic institutions.

2. **Facilitate national EM Communities of Practice (CoP).**

We will establish and facilitate national CoPs in the EM space as platforms for self-mobilizing knowledge exchange in the community and for promoting interdisciplinary research, best practice, and knowledge mobilization.

3. **Offer student/staff exchanges.**

We will foster professional development and training opportunities for students and staff through research exchange efforts across an international network of participating EM facilities.



**BREAKTHROUGH  
MATERIALS RESEARCH**

*CCEM's image of the 3-D surface of electrodes aided in the development of a new sensor that can directly monitor prostate cancer. This allows for quicker diagnostics, and improved monitoring and management of the disease.*

*Publication: Angew. Chem. 2020, 132, 2-8.*

# Guiding Principles

## INSPIRATION:

We strive to educate and inspire within the scientific and technological community, as well as the general public. To showcase the enthusiasm of our staff and users, and the exciting research undertaken, CCEM will continue to engage in professional and public outreach and training.

## ACCESSIBILITY:

CCEM is committed to providing services to a large interdisciplinary user base across academia, government laboratories and the private sectors. We believe that scientific discovery can truly flourish when training and education is readily available, and researchers with different backgrounds and sets of knowledge are given the opportunity to work together.

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*Catalyzing tomorrow's materials innovations.*

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## ACCOUNTABILITY:

CCEM is committed to accountability by upholding an environment of trust, responsibility, transparency, and return on investment through our internal governance structures, external research communities, funding agencies, and public sponsors. Strong governance and effective management will guide our organizational development.

## INCLUSIVE TEAMWORK:

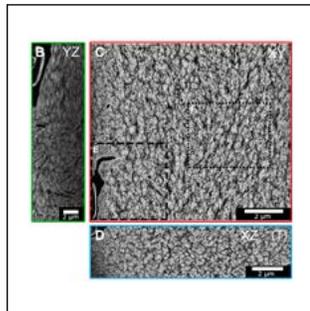
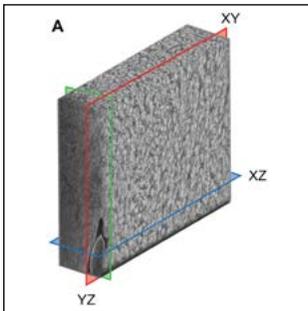
Science can help create a better world for future generations. We will engage the best innovators from different ethnic, social, and scientific backgrounds to participate in solving today's most challenging problems and building a better tomorrow for all.

## EXCELLENCE:

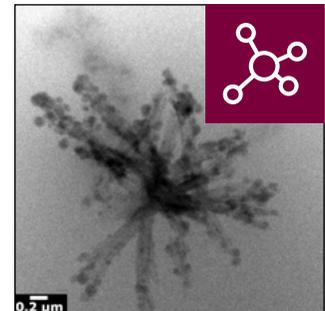
We aim to be the best in performing scientific analysis and producing publishable results. We will apply best practices and quality controls to ensure that research meets the highest international standards.



## BREAKTHROUGH MATERIALS RESEARCH



*Liquid-cell transmission electron microscopy (TEM) was used to study for the first time the evolution of the microstructure of Portland cement at the nanoscale during hydration, and in the presence of nano-silica particles. Improvement in the use or durability of concrete ultimately can reduce the carbon footprint of the planet as concrete is the world's most widely used human-made material, whose manufacturing accounts for 8% of the global greenhouse gas emissions.*



*Human bone was investigated using plasma focused ion beam (PFIB) tomography for the first time. This allows for the understanding of the architecture of bio-self assembly in bone growth, potentially paving the way for new implant materials for orthopedic applications.*

*Publication: Reprinted from Journal of Structural Biology, 212, D. M. Binkley, J. Deering, H. Yuan, A. Gourrier, K. Grandfield, Ellipsoidal mesoscale mineralization pattern in human cortical bone revealed in 3D by plasma focused ion beam serial sectioning, 107615, (2020), with permission from Elsevier.*

# Connectivity

## ASPIRATION:

We strive to build and strengthen our connectivity to national and international players in the intersecting domains of materials characterization, material development and materials applications in order to:

- Enhance our capabilities and capacity in the delivery of our EM research, training, and services
- Enhance our contributions to the scale and scope of materials innovations that are important to the prosperity, health, and security of Canadians

## CAPABILITIES FOCUS:

We strive to be best-in-class in all we do, while recognizing that there are bounds on the capabilities in which we can excel. Our focused capabilities for excellence and impact include:

- **Materials characterization:** microscopy (electron, ion, atom probe); chemical characterization in 2-D and 3-D (electron energy loss spectroscopy, atom probe tomography, 3-D focused ion beam sectioning w/spectroscopy); structure (electron backscatter diffraction, 4-D scanning transmission electron microscopy); dynamic: in-situ microscopy (liquid, cryo-heating, correlated electrons), correlative (linkages across length and time scales); computational microscopy (acquisition and post-processing)
- **Materials development:** functional, structural, metals, semiconductors, nanomaterials, 2-D materials, soft polymers, and biological samples
- **Materials applications:** advanced manufacturing, infrastructure, quantum computing, biomedical and life sciences, defence, and clean energy

## PARTNERSHIP FOCUS:

To achieve our aspiration, we will pursue value-added partnerships with the following academic, public and private sector organizations that are recognized CoEs in their specific domains:

- **Materials characterization:** International CoEs (e.g. National Institute of Standards and Technology, SuperSTEM), national CoEs in EM and correlative

techniques (e.g. National Research Council Canada (NRC) Nanotechnology Research Centre, Canadian Light Source, McMaster Center for Advanced Light Microscopy); Microscope designers/manufacturers (e.g. ThermoFisher Scientific, Fibics), SMEs (e.g. TechInsights)

- **Materials development:** National CoEs (e.g. Brockhouse Institute for Materials Research, Xerox Research Centre of Canada), International Universities and Funding Agencies
- **Materials applications:** National CoEs (e.g. NRC, Advanced Materials Research Facility, Natural Resources Canada, CANMET, Defense Research and Development Canada, Canadian Nuclear Laboratories, Hydro-Quebec (IREQ)), national superclusters (e.g. Next Generation Manufacturing Canada), agencies that support materials commercialization (e.g. NRC Industrial Research Assistance Program, McMaster Innovation Park, Synapse Life Science Consortium)



## LEADING IN EDUCATION AND TRAINING



*"It [CCEM Summer School] was extremely useful in all aspects – lectures, hands-on demos, and a chance to network and get to know others in the field."*

*– Anonymous attendee/lecturer 2019*

# Measuring Success

Over the course of the next five years, we will systematically measure our progress towards the goals set out in our Strategic Plan and will adjust to meet expectations. We will compare progress to expectations through four lenses.

## PLAN IMPLEMENTATION:

Are we on track in implementing the Plan's objectives? If not, are we taking appropriate action to get back on track?

## OUTCOMES AND IMPACT:

As we progress with the Plan's implementation, are we seeing improvements in our national and international outcomes and impacts to which the Plan aspires? If not, are we taking appropriate action to adjust our Plan to achieve the aspiration? Are we seeing improvements in our national and international impacts, as captured in our key performance indicators to which the Plan aspires?

## STAKEHOLDER EXPECTATIONS:

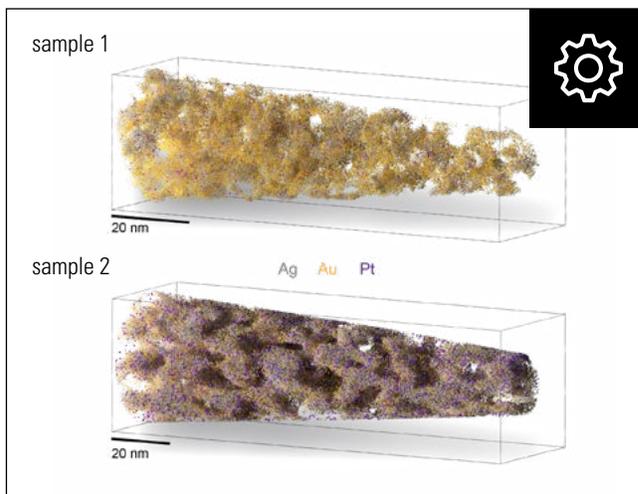
Are we meeting and exceeding the expectations of our stakeholders, including our partners, customers, funders, including CFI-MSI, staff and students? If not, are we taking appropriate action to address our shortfalls?

## INDEPENDENT EXPERT REVIEW:

At approximately the half-way point in the Plan's lifetime, we will invite a panel of independent subject matter experts to review CCEM and progress towards the goals set out in our Strategic Plan.



## PROVIDING SPECIALIZED SERVICES



*Pt-modified nanoporous Au-Ag structures were measured at CCEM with one of the first large volume (>100 nm) atom probe tomography analysis of nanoporous material using the Cameca LEAP 4000X HR atom probe. The high surface area-to-volume ratio of nanoporous metals, along with their electroactivity, make them of high interest for developing applications in catalysis, heat exchange, and electrochemical sensing.*

*Publication: Adapted from Nanoscale, 2018, 10 4904-4912 with permission from The Royal Society of Chemistry*



Canadian Centre for  
Electron Microscopy