THE UNIVERSITY OF BRITISH COLUMBIA

Materials & Manufacturing Research Institute

Annual Report 2018-2019

Collaborative Expertise for Innovative Solutions

Summary and Highlights

- Collaborative research initiatives: Multidisciplinary Undergraduate Research Projects in Health through UBC PURE competition; Cluster of Research Excellence on Biocomposites through UBCO Eminence program; Seed Funding to Support University-Industry Projects through the National Research Council of Canada Industrial Research Assistance Program
- Members: 83 academic and 53 industry
- Members success: Over $20M research funding; Over 230 articles; Nearly 60 alumni
- Events: New Horizons in Cardiovascular Health Symposium; University-Industry Interaction Series for Impactful Innovations; 11th Canadian–International Conference on Composites; Speaker Series
- Supporting team-based grant proposals: A NSERC CREATE on Advacned Bio-based Materials; Multiple funding proposals submitted to UBCO Eminence, NRC-IRAP CTO, UBC PURE, IC-IMPACTS, Innovative Solutions Canada, Climate Action Fund
- Communications: Launch of MMRI monthly newsletter
- Staffing: Added one part-time research engineer to the staff team through the awarded grants

Materials and Manufacturing Research Institute (MMRI) is a multidisciplinary, interdepartmental research hub at the University of British Columbia (UBC) fostering collaboration between local, national and international R&D sectors.

Mission

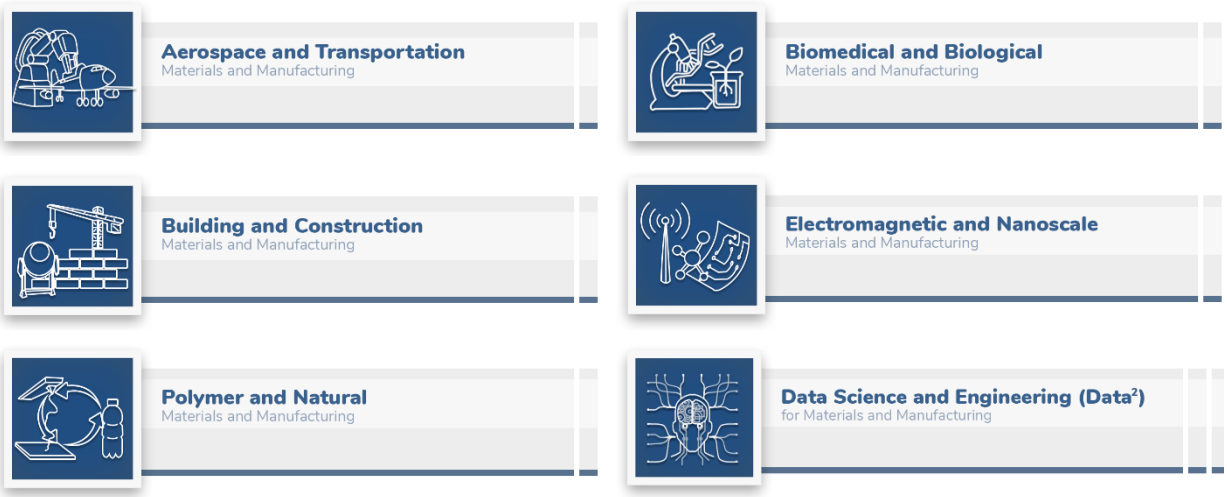
To build on UBC's existing strengths in materials and manufacturing research and create new opportunities for multidisciplinary research in related emerging areas through shared knowledge and network-based funding.

Vision

MMRI will be a role model linking basic and applied science and contributing to knowledge advancement in multidisciplinary research areas of advanced materials and manufacturing, through close partnership between UBC faculty and other sectors of academia, industry and government organizations; and by world-class training of students and scientists, and dissemination of high-quality research.

OPERATIONS

Structure: MMRI currently has six research pillars that host researchers from a wide range of disciplines across both campuses of UBC and beyond. These pillars include:



In addition, the Institute has launched a Cross-Disciplinary Initiative on Design for Industry 4.0 to foster concerted activities among members around the emerging field of smart manufacturing and factories of the future.

Management team: Each MMRI research pillar has one dedicated Lead from the Point Grey campus and one Lead from the Okanagan campus who oversee and coordinate the pillar activities. A Chief Development Officer is also leading Cross-Disciplinary Initiative. The MMRI management team is listed below:

- Director: Dr. Abbas Milani (Engineering, UBCO)
- ATMM Leads:
  - Dr. Warren Poole (Materials Engineering, UBCV)
  - Dr. Lukas Bichler (Engineering, UBCO)
- BBMM:
  - Dr. York Hsiang (Surgery, UBCV)
  - Dr. Hadi Mohammadi (Engineering, UBCO)
- BCMM:
  - Dr. Nemkumar Banthia (Civil Engineering, UBCV)
  - Dr. Shahria Alam (Engineering, UBCO)

- ENMM:
  - Dr. Lorne Whitehead (Physics and Astronomy, UBCV)
  - Dr. Kenneth Chau (Engineering, UBCO)
- PNMM:
  - Dr. Frank Ko (Materials Engineering, UBCV)
  - Dr. Gino DiLabio (Chemistry, UBCO)
- DSEMM:
  - Dr. Bhushan Gopaluni (Chemical and Biological Engineering, UBCV)
  - Dr. John Braun (Mathematics, UBCO)
- Design for Industry 4.0:
  - Dr. Homayoun Najjaran (Engineering, UBCO)

Membership: MMRI continues to integrate new members from academia and industry into its research structure. The Institute currently boasts 83 academic and 53 industry members.

Space/facilities: Since January 2018, the institute has been officially located in EME 2131 on UBC Okanagan campus.

Staff and administration: MMRI currently has two full-time and one part-time staff as listed below:

- Research Engineer:
  - Dr. Mahdi Takaffoli, full-time
  - Mr. Daanvir Dhir, part-time
- Administrative Assistant:
  - Ms. Jolene Campbell

ACADEMIC MEASURES

The academic measures reported in this section is based on the information collected from members on their academic records from September 2018 until August 2019.

Grants: MMRI members has received over $20M research funding from different funding sources. See Appendix I for the list of sample grants.

Publications: MMRI members published 239 articles in peer-reviewed journals. See Appendix II for the list of sample publications.

Trainee supervision: MMRI members have supervised 86 PhD students, 110 master's students, and 92 undergraduate research assistants. In addition, they hosted 40 postdoctoral fellows and 34 visiting scholars in their labs. See Appendix III for the list of current trainees.

Graduated trainees/alumni: Nearly 60 alumni have gained research experience under the guidance of MMRI members. See Appendix IV for the list of graduated trainees.

Student/alumni success stories

Kiana Mirshahidi and Ben Wiltshire

Next-generation ice detection sensor

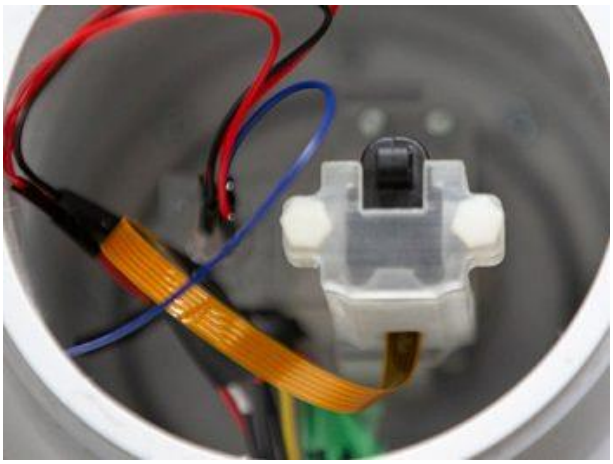
Mohamed Gamal

Injectable tissues

Dylan Goode

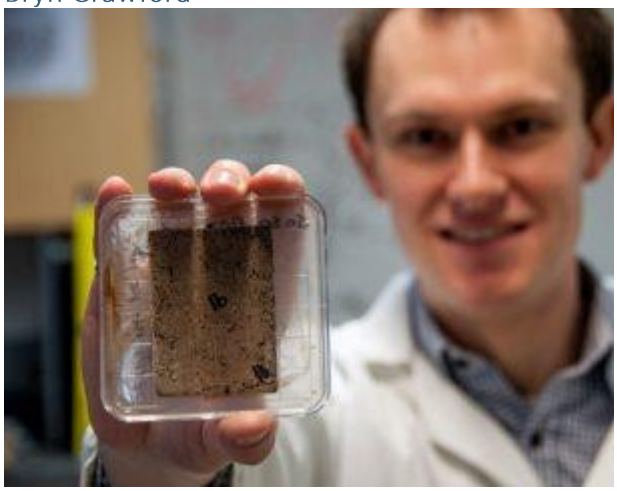
New heart valve aimed at high-risk patients

Mohammad Paknahad



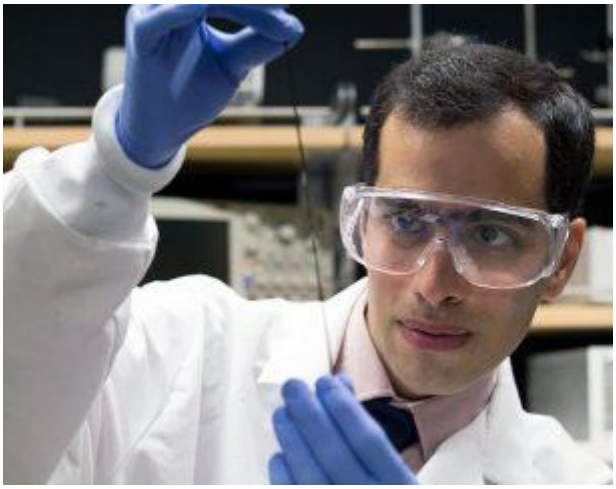
High-level gas detection system

Bryn Crawford



Bacterial degradation of natural composites

Hossein Montazerian



Washable sensor

ACTIVITIES AND PROJECTS

Collaborative research initiatives

Multidisciplinary Undergraduate Research Projects in Health (MURPH): MMRI in collaboration with the Institute for Healthy Living and Chronic Disease Prevention, and Centre for Heart, Lung & Vascular Health received a funding award through UBC's Program for Undergraduate Research Experience (PURE) competition to establish the MURPH undergraduate research program at UBCO. MURPH offers a unique cross-disciplinary platform to undergraduate students for engaging in academic research, while also getting professionalization training through specific-designed workshops. 9 projects are currently funded by MURPH over 2019-2020 involving 22 undergraduate research assistants and 18 faculty members. MURPH is managed by a committee comprising Drs. Joan Bottorff (Nursing), Neil Eves (Human Kinetics), Harry Miller (Psycology), Abbas Milani (Engineering), Natalie Forssman (Engineering), and Mahdi Takaffoli (MMRI). To assist the management committee with executing the program, 2 graduate students have also been hired. MURPH is honored to get support from Faculty of Health and Social Development, Southern Medical Program, and School of Engineering.

Cluster of Research Excellence on Biocomposites: MMRI coordinated the establishment of this Eminence-funded research cluster which brings together a multi-disciplinary team of researchers next to industry partners and government authorities to better understand and enhance the synthesis, processing, properties and compounding of bioplastic and bio-fibre materials and to produce innovative biocomposite products. The research will focus on the entire production supply chain, from biomass feedstock genetics and biocomposites manufacturing to multi-criterial performance assessment of the final product, including durability, end-of-life design and socio-economic impact. The core academic team involved in this cluster includes: Drs. Abbas Milani (Engineering), Michael Deyholos (Biology), Kasun Hewage (Engineering), Parisa Mehrkhodavandi (Chemistry), Cigdem Eskicioglu (Engineering), Sepideh Pakpour (Engineering), Kevin Golovin (Engineering), Frank Ko (Engineering), Wesley Zandberg (Chemistry), and Philip Evans (Forestry).

Technical Assistance to Small and Medium-Sized Companies in British Columbia: MMRI in collaboration with The National Research Council of Canada Industrial Research Assistance Program (NRC IRAP) implemented and managed a financial support program for university-industry projects that are led by UBC researchers and aimed at offering technical assistance in materials and manufacturing to BC-located small and medium-sized enterprises (SMEs). 16 projects were awarded through this program among which some advanced to the next step through other funding including Mitacs and NSERC.

Event organization

New Horizons in Cardiovascular Health Symposium

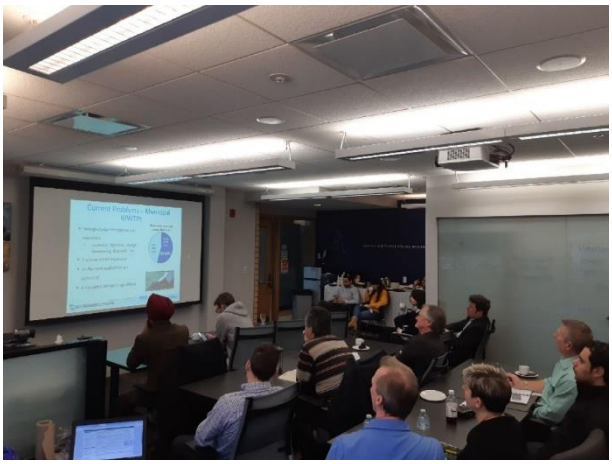
September 12, 2019 | The Innovation Centre, Kelowna, BC

- 23 talks under themes of cardiovascular biology and physiology, biomaterials, devices, wearable technologies, and imaging.
- 12 talks under the Innovator's Corner theme; A unique training and experience-sharing program on entrepreneurship and business development in health technologies.
- 5 companies showcased their products in the exhibition.
- Over 100 attendees from academic, industry, and government organizations.
- Comments from attendees received through an online survey: "Great content, stimulating ideas, fantastic presenters"; "the format was excellent"; "I found the conference very interesting and extremely helpful"; "an excellent mix of speakers and topics".

University-Industry Interaction Series for Impactful Innovations

- Five weekly sessions from Jan. 30 until March 6, hosting 16 academic and 14 industry speakers.

UBC Vancouver



UBC Okanagan

11th Canadian–International Conference on Composites, CANCOM2019

July 22-25, 2019 – Kelowna, British Columbia, Canada

- Over 120 academic and industry attendees.
- Pre-conference workshops: Processing and Process Simulation of Advanced Composites; Introduction to Machine Learning in Engineering Applications.
- A specific The Women in Composites session.

Invited seminars

- Aerogels and Aerogel Composites
  - Dr. Barbara Milow, German Aerospace Center; April 3, 2019
- Fractional Calculus and Its Emerging Applications in Materials and Manufacturing
  - Dr. Reza T. Faal, Visiting Professor; April 3, 2019
- Nano-engineered Membranes for Water and Energy Harvesting from Wastewater
  - Dr. Jongho Lee, Assistant Professor, Civil, UBCV; March 7, 2019
- Sensing, Modeling, and Data Analytics to Observe Human Brain Injury
  - Dr. Lyndia Wu, Assistant Professor, Mechanical, UBCV; March 6, 2019
- Bioinspired Optimal Adhesion & Cell Contraction by Molecular Motors
  - Dr. Mattia Bacca, Assistant Professor, Mechanical, UBCV; February 27, 2019
- 3D Printing of Bio-inspired Cellular Structures
  - Dr. Sardar Malek, Lecturer, UTS, Australia; December 4, 2018
- Modelling, Control and Optimisation of Complex Energy Systems
  - Dr. Hamid Khayyam, Senior Lecturer, RMIT, Australia; September 27, 2018
- 3D Carbon Fibre and Composite Research @ Deakin: An overview
  - Dr. Dr. Minoo Naebe, Deakin University, Australia; September 27, 2018
- Start-up Financial Planning
  - Isa Habash, Financial Security Advisor, Freedom 55 Financial; March 16, 2019

Supporting research grant proposals

Grant writing: MMRI continually seeks for opportunities to facilitate and support team-based research grant applications and bring new funding resources for its members. The list below exemplifies some of the major grants that received planning and development support from MMRI staff.

Eminence; Immersive Technologies for Smart and Creative Solutions ⧖

- Led by Dr. Zheng Liu (Eng.) and Dr. Khalad Hasan (Computer Science) in collaboration with 13 faculty members
- Requested funding: $399,000 for three years

NSERC CREATE; Advanced Bio-based Materials ⧖

- Led by Dr. Parisa Mehrkhodavandi (Chemistry) in collaboration with 9 faculty members
- Requested funding: $1,650,000 for six years

NRC-IRAP, Contributions to Organizations funding; Providing Multidisciplinary Technical Services in Materials and Manufacturing to SMEs in British Columbia ✓

- Led by Dr. Abbas Milani (Eng.)
- Requested funding: $133,756 for nine months

NRC-IRAP, Contributions to Organizations; Providing Scientific and Economic Advice and Assistance to BC SMEs to Leverage the Circular Economy ⧖

- Led by Dr. Abbas Milani (Eng.)
- Requested funding: $299,760 for two years

UBC PURE, Multidisciplinary Undergraduate Research Projects in Health ✓

- Led by Dr. Mahdi Takaffoli in collaboration with 5 faculty members
- Requested funding: $98,840 for two years

IC-IMPACTS, Innovative, Low-cost, Energy-efficient, and Resilient Pit House ✗

- Led by Dr. Shahria Alam (Eng.) and Dr. Jeannette Armstrong (Community, Culture and Global Studies)
- Requested funding: $318,000 for two years

Climate Action Fund, Collaborative Interdisciplinary Climate Action Project ✖

- Led by Dr. Abbas Milani (Eng.)
- Requested funding: $119,250 for two years

Networking with other UBC institutes/centers: MMRI is committed to avoid acting in silo and disconnected from other institutes at UBC. The management team has been actively reaching out to various institutes, research centers and key figures on both campuses to identify synergistic collaborative opportunities. The internal networking activities during the report period include: School of Biomedical Engineering (Dr. Peter Zandstra, Dr. Payam Zahedi), Biomedical Imaging & Artificial Intelligence Research Cluster (Dr. Tim Salcudean), Bionics Network (Dr. John Madden, Dr. Adam Fraser), Southern Medical Program (Dr. Allan Jones, Dr. Harry Miller), The Institute for Healthy Living and Chronic Disease Prevention (Dr. Joan Bottorff), Centre for Heart, Lung & Vascular Health (Dr. Neil Eves), Okanagan Institute for Biodiversity, Resilience and Ecosystem Services (Dr. Lael Parrott).

Success story in collaboration with UBC Survive and Thrive Applied Research (STAR)

Comfort-Optimized Materials for Operational Resilience, Thermal-transport and Survivability: COMFORTS network received $1.5 million from the Canadian government through the Innovation for Defence Excellence and Security (IDEaS) program. The network involves 11 researchers from UBC, two lead collaborators at the University of Alberta and the University of Victoria, and numerous industry partners.

Community Outreach and Communications

MMRI Newsletter: To keep the members informed of MMRI activities, a newsletter was launched this past year and 5 issues have been sent out. A special "Meet a Member!" column in the newsletter was also introduced that intends to promote members through a short interview.

Dr. Lyndia Wu, Assistant Professor, Mechanical Engineering

What interests you the most when working in the education sector and why? The opportunity to inspire young minds and train the next generation of engineers and researchers, as well as the endless possibilities in both research and teaching.

What will be the next big development in your field? Small, low-power, low-cost, non-intrusive wireless wearable sensors that can provide real-time monitoring of health conditions and early diagnosis of disease.

What is the one thing people would be surprised to know about you? With research on wearable sensing, I have a good collection of biomechanics and physiological data gathered from myself.

Describe yourself in one word. Driven.

Dr. York Hsiang, Professor, Faculty of Medicine

What interests you the most when working in the education sector and why? I enjoy working with young enthusiastic minds. It raises everybody's energy levels!

What will be the next big development in your field? In vascular biology, there has been a disconnect between understanding the disease processes and mechanical methods of treating vascular conditions. Arteries and veins are not simply tubes that contain non-Newtonian fluid. The cells that determine the shape and function of these conductance vessels in health and in disease are subject to fluid and mechanical forces. I would like to see a joint vascular biology and engineering effort to address vascular pathology.

What is the one thing people would be surprised to know about you? I

Outreach Communications: To build a stronger connection with local professional communities and promote the activities of our researchers, the MMRI Research Engineer is collaborating with Accelerate Okanagan as a #OKGNtech columnist on Advanced Manufacturing News.

GOALS FOR NEXT YEAR

- Manage the MMRI-NRC IRAP seed funding for university-industry projects: We have set a goal of supporting 18 university-industry projects from September 2019 until June 2020.
- Continue supporting team-based proposals: We will remain committed to support planning, team building and writing multidisciplinary proposals for different funding programs, such as Eminence, NSERC CREATE, Mitacs, NSERC Alliance.
- Focus on building capacity for research and industry support toward circular economy: We plan to apply for funding through Western Economic Diversification Canada programs and NRC-IRAP to launch new initiatives in BC around circular economy. In addition, focus group meetings will be organized to create synergy among different stakeholders from academia and industry for collaborative activities.
- Foster cross-departmental and cross-campus research collaboration: We plan to organize a networking event among faculty members in collaboration with Southern Medical Program and Faculty of Health and Social Development. We will continue arranging talks for MMRI members in their non-resident UBC campus.
- Engage in joint international initiatives: Through the Biocomposites Cluster, we plan to organize a joint workshop with Indian Institute of Technology, Roorkee on bio-based materials.
- Develop and implement a plan for MMRI indigenization activities: In close collaboration and consultation with The Institute for Community Engaged Research and the Indigenous Community Liaison in the Office of Research Services at UBCO, we intend to develop a plan and undertake a number of activities to grow our support and involvement with Indigenous communities.

CONTACT INFORMATION

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APPENDIX I: LIST OF SAMPLE GRANTS

Member Name	Cluster	Faculty	$ Amt Received	Major Grants/Contracts
Lukas Bichler	ATMM	Applied Science	$429,000	NSERC-CRD
Joshua Brinkerhoff	ATMM	Applied Science	$428,200	Mitacs, NSERC Engage, Industry contracts
Fatemeh Fard	ATMM	IKBSAS	$127,500	NSERC Discovery, Mitacs Globalink
Chen Feng	ATMM	Applied Science	$1,777,260	NSERC Engage, Mitacs Accelerate, IDEaS, NSERC CREATE
Sunny Li	ATMM	Applied Science	$60,000	Mitacs, NSERC Engage
Abbas Milani	ATMM	Applied Science	$2,130,205	Mitacs Accelrate, UBC Eminence, DND (IDEaS and MicroNets), SSHRC (Partnership Engage Grant), Industry contracts
Dimitry Sediako	ATMM	Applied Science	$254,000	NSERC CRD, Mitacs Accelerate
Rudolf Seethaler	ATMM	Applied Science	$55,000	UBC Eminence Fund, NSERC DG, NSERC CRD
Jin Xiaoliang	ATMM	Applied Science	$901,000	CFI + BCKDF, NSERC CRD, MMRI-NRC IRAP, CRC Tier 2 in Advanced Manufacturing
Zheng Liu	ATMM	Applied Science	$944,733	Mitacs Accelerate, NSERC CRD, Microsoft, Government of Canada (DND)
Isaac Li	BBMM	IKBSAS	$270,700	Work-Study, New Frontiers Research Fund
Andrew Jirasek	BBMM	IKBSAS	$587,168	UBCO Eminence Fund, Moss Rock Park Foundation, BC Cancer Foundation, NSERC RTI

Hadi Mohammadi	BBMM	Applied Science	$201,000	NSERC DG, NSERC Engage, Mitacs Accelerate
Sepideh Pakpour	BBMM	Applied Science	$800,000	Mitacs Accelerate, CFI, Broad Center for Microbiome Informatics & Therapeutics grant, UBCO Eminence
Lyndia (Chun) Wu	BBMM	Applied Science	$700,000	New Frontiers in Research Fund, Michael Smith Foundation for Health Research Scholar Award
Sumi Siddiqua	BCMM	Applied Science	$425,000	NSERC Discovery, Mitacs Elevate & Accelerate
Warren Hare	BCMM	IKBSAS	$1,000,000	NSERC DG, Mitacs, NSERC SPG, NSERC CRD
Mohammad Hasan	DSEMM	IKBSAS	$185,000	NSERC Discovery, Two Workstudy, One MURPH
Apurva Narayan	DSEMM	Applied Science	$777,000	NSERC CRD, NSERC Discovery, Mitacs Accelerate
Jian Liu	ENMM	Applied Science	$595,000	Mitacs Accelerate Cluster, NSERC CRDBC, BC Clean Energy Vehicle Advanced Research and Commercialization (ARC) Program
Jeffrey Andrews	ENMM	IKBSAS	$55,000	NSERC Discovery Grant, Mitacs Accelerate, NSERC Engage
Robert Godin	ENMM	IKBSAS	$569,409	NSERC Discovery, NSERC RTI, CFI-JELF, BCKDF
Loic Markley	ENMM	Applied Science	$66,167	NSERC Discovery, RTI
Lorne Whitehead	ENMM	Physics & Astronomy	$227,408	US DOE, Peter Wall Institute for Advanced Studies, Bay View Alliance, Global Affairs Canada, Quantum Matter Institute Seed Fund, Jewish Community Federation and Endowment, and Nanomedicines Innovation Network

Parisa Mehrkhodavandi	PNMM	Science	$68,000	NSERC Discovery
Alexander Uhl	PNMM	Applied Science	$266,500	NSERC Discovery, NSERC RTI
Mohammad Arjmand	PNMM	Applied Science	$1,200,000	NSERC CRC, NSERC CFI, NSERC Engage, Mitacs, Startup, DND, NRC IRAP, UBC Work Study
Michael Deyholos	PNMM	IKBSAS	$120,000	Mitcas, NSERC Engage NSERC DG
Kevin Golovin	PNMM	Applied Science	$844,490	NSERC Discovery, NSERC CRD, DND IDEaS CPs, Micro-net, PWIAS, CFI, Mitacs
Feng Jiang	PNMM	Forestry	$335,000	NSERC Engage, CFI
Jongho Lee	PNMM	Applied Science	$324,000	CFI JELF, Investment Agriculture Foundation BC
Cigdem Eskicioglu	PNMM	Applied Science	$3,758,672	NSERC/Metro Vancouver Industrial Research Chair (IRC) (Pending), NSERC CRD, Mitacs Accelerate, UBCO Eminence, Horizon 2020 Marie Skidowska Curie Global Fellowship
Total			$20,482,412	

APPENDIX II: LIST OF SAMPLE PUBLICATIONS

ATMM

1) L. Malakkal, A. Prasad. D. Oladimej, E. Jossou, J. Ranasinghe, B. Szpunar, L. Bichler and J. Szpunar, 2019, "Atomistic and experimental study on thermal conductivity of bulk and porous cerium dioxide", Nature Scientific Reports.

2) A. Prasad, L. Malakkal, J. Szpunar and L. Bichler, 2019, "Optimizing processing conditions for Thorium Dioxide using Spark Plasma Sintering", Acers Ceramic Transactions, Vol. 266 (In press)

3) A. Prasad, L. Lafortune, J. Mok and L. Bichler, 2019, "An Investigation on Spark Plasma Sintering of a Carbon Black Grain Refiner for B319 Aluminum Alloy", Transactions of Indian Institute of Metals,

4) A. Prasad, J. Mok, L. Lafortune and L. Bichler, 2019, "Grain refinement of B319 Aluminum Alloy using Spark Plasma Sintered Al-Ti-C Grain Refiners", Transactions of Indian Institute of Metals, 2018, Vol. 71, pp. 2759 – 2764

5) T. Davis, L. Bichler, F. D'Elia and N. Hort, 2018, "Effect of TiBor Grain Refinement on Hot Tearing Susceptibility of AZ91D Magnesium Alloys", Journal of Alloys and Compounds, Vol. 759, pp. 70 – 79

6) T. Davis and L. Bichler, 2018, "Novel Fabrication of a TiB2 Grain Refiner and its Effect on Reducing Hot Tearing in AZ91D Magnesium Alloy", Journal of Materials Engineering and Performance, Vol. 27, Issue 9, pp. 4444 – 4452

7) Haji Mohammadi, M., Sotiropoulos, F. and Brinkerhoff, J.R. (2019) "Euler-Euler large eddy simulation of two-phase dilute bubbly flows", Chemical Engineering Science. 208, 115156.

8) Karunathilake, H., Hewage, K, Brinkerhoff, J.R., Sadiq, R. (2019), "Optimal renewable energy supply choices for net-zero ready buildings: A life cycle thinking approach under uncertainty," Energy and Buildings, 201, 70-89.

9) Haji Mohammadi, M. and Brinkerhoff, J.R. (2019), "Large eddy simulation of an axial pump with coupled flow rate calculation using the sharp interface immersed boundary method," International Journal of Numerical Methods in Heat and Fluid Flow, (Accepted Feb. 27/2019)

10) Haji Mohammadi, M., Sotiropolous, F. and Brinkerhoff, J.R. (2019), "Moving Least Squares Reconstruction for Sharp Interface Immersed Boundary Methods," International Journal of Numerical Methods in Fluids, 90, 57-80.

11) Moallemi, N. and Brinkerhoff, J.R. (2018), "Numerical Analysis of Transitional Flow in an Axisymmetric Sudden Expansion," International Journal of Heat and Fluid Flow, 72, 161-173.

12) Fard, Fatemeh Where does LDA sit for GitHub? International Workshop of Software Engineering Intelligence, Automated Software Engineering Workshop Series, Accepted.

13) Cheng Guo, Liqiang Zhao, Chen Feng, Zhiguo Ding, and Hsiao-Hwa Chen, "Energy Harvesting Enabled NOMA Systems with Full-duplex Relaying," IEEE Transactions on Vehicular Technology, vol. 68, no. 7, pp. 7179-7183, July 2019.

14) Sung-Hoon Lim, Chen Feng, Adriano Pastore, Bobak Nazer, and Michael Gastpar, "A Joint Typicality Approach to Compute-Forward," IEEE Transactions on Information Theory, vol. 64, no. 12, pp. 7657-7685, December 2018.

15) Cheng Guo, Abdelmalik Aljalai, Chen Feng, Liqiang Zhao, Victor Leung, and Rabab Ward, "Compute-and-Forward for Uplink Non-Orthogonal Multiple Access," IEEE Wireless Communications Letters, vol. 7, no. 6, pp. 986-989, December 2018.

16) Chunpu Wang, Chen Feng, and Julian Cheng, "Distributed Join-the-Idle-Queue for Low Latency Cloud Services," IEEE/ACM Transactions on Networking, vol. 26, no. 5, pp. 2309-2319, October 2018.

17) Wei Cai, Zehua Wang, Jason B. Ernst, Zhen Hong, Chen Feng, and Victor Leung, "Decentralized Applications: The Blockchain Empowered Software System," IEEE Access, vol. 6, pp. 53019-53033, September 2018.

18) Chen Feng, Nan Li, M.H. Franco Wong, and Mingyue Zhang, "Initial Coin Offerings, Blockchain Technology, and White Paper Disclosures," in Proc. of China International Conference in Finance (CICF), Guangzhou, China, July 2019, 38 pages. (Acceptance rate 18.1%)

19) Yuwei Guo, Jinfeng Tong, and Chen Feng, "A Measurement Study of Bitcoin Lightning Network," in Proc. of IEEE International Conference on Blockchain (Blockchain-2019), Atlanta, USA, July 2019, 10 pages. (Acceptance rate 15.9%)

20) Sung-Hoon Lim, Chen Feng, Adriano Pastore, Bobak Nazer, and Michael Gastpar, "Towards an Algebraic Network Information Theory: Distributed Lossy Computation of Linear Functions," in Proc. of IEEE International Symposium on Information Theory (ISIT), Paris, France, July 2019, 5 pages.

21) Jianyu Niu and Chen Feng, "Selfish Mining in Ethereum," in Proc. of IEEE International Conference on Distributed Computing Systems (ICDCS), Dallas, TX, July 2019, 11 pages. (Acceptance rate 19.6%)

22) G. Xuan, R. Li, "Experimental and analytical study of transient convection at film flow-wall interface using infrared thermography," International Journal of Thermal Sciences 145, 106023 (2019).

23) Y.D. Cao, G. Xuan, R. Li, "A liquid plug moving in an annular pipe – Heat transfer analysis," International Journal of Heat and Mass Transfer 139, 1065–1076 (2019).

24) Y.D. Cao, R. Li, "A liquid plug moving in an annular pipe—Flow analysis," Physics of Fluids 30, 093605 (2018).

25) X. Gao, R. Li, "Impact of a drop burst flow on a film flow cooling a hot surface," International Journal of Heat and Mass Transfer 126, 1193–1205 (2018).

26) D. Karimi, A. S. Milani, (2019) "SRVE modeling of particulate polymer matrix composites with irregularly shaped inclusions: Application to a green stone composite", Composite Structures, 228: 111331

27) D. Karimi, A. S. Milani, F. Alavi (2019) "Recycled stone/ABS particulate composite: Micromechanical finite element fracture analysis", Composites Part B (in press)

28) H. Montazerian, M.G.A. Mohamed, M. M. Montazeri, S. Kheiri, A. S. Milani, K. Kim, M. Hoorfar (2019) "Permeability and mechanical properties of gradient porous PDMS scaffolds fabricated by 3D-printed sacrificial templates designed with minimal surfaces", Acta Biomaterialia , 96(15): 149-160

29) H. Souzangarzadeh, A. Jahan M. J. Rezvani, , A. S. Milani (2019) "Multi-objective optimization of cylindrical segmented tubes as energy absorbers under oblique crushes: D-optimal design and integration of MULTIMOORA with combinative weighting", Structural and Multidisciplinary Optimization (In press)

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APPENDIX III: LIST OF TRAINEE SUPERVISION

Member	Cluster	PhD	MSc	MEng	URAs	PDF/Research Associates	Visiting Scholars
Lukas Bichler	ATMM	3	5	2	2	1	0
Joshua Brinkerhoff	ATMM	4	5	2	2	3	0
Fatemeh Fard	ATMM	0	0	0	4	0	0
Cheng Feng	ATMM	5	5	1	1	1	1
Sunny Li	ATMM	3	1	2	2	1	0
Abbas Milani	ATMM	5	6	1	5	1	4
Rudolf Seethaler	ATMM	5	3	4	1	0	1
Xiaoliang Jin	ATMM	5	3	2	0	0	2
Zheng Liu	ATMM	6	7	0	3	2	5
Isaac Li	BBMM	2	2	0	4	2	1
York Hsiang	BBMM	0	0	0	0	7	0
Hadi Mohammadi	BBMM	3	6	4	4	0	0
Sepideh Pakpour	BBMM	3	1	1	5	1	3
Lyndia (Chun) Wu	BBMM	1	2	1	7	0	0
Sumi Siddiqua	BCMM	6	7	1	4	2	0
Warren Hare	BCMM	0	2	0	2	2	0

Mohammad Hasan	DSEMM	0	1	0	4	0	0
Apurva Narayan	DSEMM	0	5	0	3	0	1
Jian Lu	ENMM	4	2	2	2	2	5
Jeffrey Andrews	ENMM	1	3	0	4	1	0
Robert Godin	ENMM	0	1	0	7	0	1
Loic Markley	ENMM	4	4	0	3	0	0
Lorne Whitehead	ENMM	1	0	0	0	2	0
P. Mehrkhodavandi	PNMM	6	1	0	5	1	0
Alexander Uhl	PNMM	1	1	0	0	0	0
Mohammad Arjmand	PNMM	4	2	1	1	3	3
Michael Deyholos	PNMM	3	0	0	0	0	0
Kevin Golovin	PNMM	3	5	0	6	3	2
Feng Jiang	PNMM	2	0	0	8	2	4
Jongho Lee	PNMM	1	1	0	0	1	0
Cigdem Eskicioglu	PNMM	5	5	0	3	2	1

APPENDIX IV: LIST OF ALUMNI

Cluster	Alumni Name	Degree/Title	Finish Date
ATMM	Ambreen Nisar	PDF	Dec 2018
	Tyler Davis	PhD	April 2019
	Siddharth Buduraju	MASc	April 2019
	Levi LaFortune	MASc	April 2019
	Dr. Ehsan Tahmasebi	PDF	June 2019
	Siddharth Siddhu	MASc	April 2019
	Nima Moallemi	PhD	August 2018
	Yonghui Lu	MASc	Dec 2018
	Junyuan Leng	MASc	Mar 2019
	Jinfeng Tong	MASc	Aug 2019
	Yadi Cao	MASc	Sep 2018
	Daanvir Karan	MASc	Aug 2019
	Dpiti Nikam	MASc	June 2019
	Haoqiu Wu	MENG	May 2019
	Sina Nezafatkhah	MASc	April 2019
	Ermia Aghaie	MASc	Aug 2019
	Stephen Kimanzi	MASc	Dec 2019
	Tanjid Hossein	MASc	Dec 2019
	Manmeet Singh	MENG	Dec 2018
	Lu Xu	MENG	Aug 2019
	Anyaoha Uchenna	MASc	Aug 2019

	Chengkai Zhang	MASc	Aug 2019
	Junchi Bin	MASc	Nov 2018
	Fang Shi	MASc	Sep 2018
	Delun Chen	BASc	Mar 2019
	Lihua Jian	Visiting Ph.D. Student	Aug 2019
	Qiwen Jin	Visiting Ph.D. Student	Sep 2018
	Hongguang Yun	Visiting Master Student	Jan 2019
	Siddhant Haldar	Visiting Undergraduate Student	Jul 2019
	Xin Fu	Visiting Undergraduate Student	Oct 2018
BBMM	Nicole Skidmore	BSc	April 2019
	Sydney Fearnley	BSc	April 2019
	Scott Minh An	BSc	April 2019
	Jon Misskey	FRSC	April 2019
	Adrien Noble	BASc in Mechanical Engineering	June 2019
	Derek Fong	BASc in Mechanical Engineering	June 2019
	Nicole Skidmore	BSc	April 2019
BCMM	Amin Bigdeli	PhD	Sep 2018
	Zillur Rahman	PhD	Oct 2018
	Derek Emslie	MASc	Nov 2018
	Priscila Barreto	MASc	Mar 2019
	Abiola Salami	MASc	May 2019

	Sohana Sabrin	MASc	Aug 2019
	Gabriel Jarry-Bolduc	MSc	May 2019
	Shima Amirshari	MSc	Sept 2019
ENMM	Elham Khodayari Moez	PhD (U of A)	Sep 2018
	Liam Welsh	BSc	May 2019
	Grady Hewlett	B. Sc.	Aug 2019
	Nibirh Jawad	MASc	Jan 2019
	Connor Badowich	MASc	Jan 2019
	Robin Atkins	Ph.D.	Jan 2020
	Faezeh Mohammadbeigi	Postdoctoral fellow (co-supervised)	Dec 2018
PNMM	Dinesh Adhikary	PhD	Sep 2018
	Ambreen Nisar	PDF	June 2019
	Chenxi Li	MASc	Aug 2019
	Gokce Kor Bicakci	PhD	Jan 2019
	Bita Nazyap	MASc	Dec 2018
	Wesley Olaya	MASc	July 2019