

## Cathleen M. Crudden

Allie Douglas Distinguished Research Professor,  
Canada Research Chair (Tier 1)

Queen's University

Research Professor, Nagoya University, ITbM



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### Current Employment

Allie Douglas Distinguished Professor, Queen's University, Kingston, Ontario, Canada  
Canada Research Chair (Tier 1), Metal Organic Chemistry, Queen's University  
Research Professor, Institute of Transformative Bio-Molecules, Nagoya University, Japan  
Associate Editor, ACS Catalysis  
Editorial Board (equiv. to Associate Editor), Organic Syntheses

### Past Employment/Visiting Professorships

2018	Visiting Professor, Université Claude Bernard Lyon 1, France
2013	Past President, Canadian Society for Chemistry
2012	President, Canadian Society for Chemistry
2012	Visiting Professor, Global Centers of Excellence, Kyoto, Japan
2011	Vice-President, Canadian Society for Chemistry
2007	Visiting Research Professor, Universitat Roviri i Virgili, Tarragona, Spain
2006	Visiting Research Professor, Nagoya University, Group of Ryoji Noyori (Nobel prize 2001)
2002–2009	Associate Professor, Queen's University
2002–2007	Queen's National Scholar, 5 year research chair (non-renewable)
2001–2002	University Research Professor, University of New Brunswick
2000	Associate Professor (tenured), University of New Brunswick
1996–2000	Assistant Professor, University of New Brunswick

### Education

1995-1996	NSERC Postdoctoral Fellow, University of Illinois at Urbana-Champaign
1991-1994	Ph.D., NSERC Postgraduate scholar, University of Ottawa Supervisor: Professor Howard Alper
1989-1990	M.Sc., University of Toronto Supervisor: Professor Mark Lautens
1985-1989	B.Sc., University of Toronto Supervisor: Professor Mark Lautens

## Honours and Awards

Arthur C. Cope Scholar, American Chemical Society, 2019  
Montreal Medal, Chemical Institute of Canada, 2019  
International Precious Metals Institute Carol Tyler award (US), 2018  
Catalysis Award, Canadian Catalysis Society, 2018  
Top paper of 2017 award, Synlett  
Queen's Excellence in Research Award, 2017  
Canada Research Chair (Tier 1), 2017-2027  
Fellow, Royal Society of Chemistry UK, 2016  
R.U. Lemieux Award for Organic Chemistry, CSC 2017  
Killam Research Fellow, 2015-2016  
Fellow, Chemical Institute of Canada, 2014  
Clara Benson Award, Canadian Society for Chemistry, 2011  
Catalysis Lectureship Award, Canadian Catalysis Society, 2011  
NSERC Accelerator Awardee, 2010 (*one of eight in Chemistry in Canada*)  
Global Centers of Excellence Visiting Professorship, Kyoto, Japan, 2008  
Merck and Company Academic Development Award, 2008  
Visiting Professorship, Catalan Government, 2007  
Awarded 8<sup>th</sup> place in Canada's Top Ten Hot Papers in Science  
(*Essential Science Indicators*), 2006  
Research Center for Materials Science Visiting Professorship, Nagoya Japan, 2006  
Johnson and Johnson Focused Giving Award, 2006  
Premier's Research Excellence Award, February 2003  
Chancellor's Research Award, January 2003  
Queen's National Scholar Award, January 2001  
Granted early promotion and tenure, July 2000  
University of New Brunswick Merit Award, June 1999  
Ichikizaki Travel award for Young Chemists, April 1999 and November 1997  
IUPAC Travel Award, December 1998  
Research and Innovation Award, December 1997  
NSERC Post-doctoral Fellowship, 1995-1996  
Ontario Graduate Scholarship, 1993-1994  
Bio-Mega / Boehringer Ingelheim Graduate Research Scholarship, 1993  
NSERC Post-graduate Fellowship, 1991-1993  
George Wright Cumulative Examination Award, 1990  
University of Toronto Open Fellowship, 1990-1991 and 1989-1990  
David McLaren Scholarship, and Ivan Szak Scholarship, 1988  
Canadian Society for Chemistry Award for Academic Excellence, 1988  
University of Toronto entrance scholarship, 1985

## Lectureships

2019, Merck-Karl Pfiser Visiting Lecturer in Organic Chemistry, Massachusetts Institute of Technology (United States)  
2019, ScotChem Lectureship (Scotland, UK)  
2017, Swiss Chemical Society Lectureship (Switzerland)

2014, Organic Reactions Lectureship, University of Illinois at Urbana-Champaign (US)  
2014, Inaugural Aldrich Lectureship, University of Michigan (US)  
2014, Keith Fagnou Memorial Lectureship, Ottawa University (Can)  
2011, Catalysis Lectureship, Canadian Catalysis Society (Can)

## **Editorial, Board and Panel Positions**

### International Journals

- Editorial Board/Associate Editor, Organic Syntheses, 2019–present
- Associate Editor, ACS Catalysis, 2016–present
- Scientific Advisory Board, ChemRxiv, 2019–present
- Editorial Advisory Board, Angewandte Chemie International Edition, 2019–present
- Editorial Advisory Board, ACS Central Science, 2018–present
- Editorial Advisory Board, Chem, 2018–present
- Editorial Advisory Board, Organometallics, 2015–2018
- Editorial Advisory Board, Chemical and Engineering News, 2014–present
- Editorial Advisory Board, Synthesis/Synlett 2013–present
- Editorial Advisory Board, Chemical Record (Japan), 2010–present

### National Journals

- Editorial Advisory Board, Canadian Journal of Chemistry, 2004-2009
- Editorial Board, Canadian Chemical News 1999-2010
- Columnist, “Chemical Shifts”, bi-monthly article in Canadian Chemical News on Canadian chemical research

### National and International Granting Agency Work

- Editorial Advisory Board, RIKEN, Japanese national labs, 2019–present
- NSERC Partnerships Grants program Evaluation Committee, 2019
- Reviewer, EPSRC graduate training centers (UK), 2018
- Member, Review panel, DFG Centers of Excellence Program (Germany) 2017–2018
- Member, Review panel, AAAS review of grants for Saudi Arabia (US), 2018
- Chair, National NSERC–Chemistry Liaison Committee, 2017–present
- Chair, Strategic Grants Panel, Competitive Manufacturing, NSERC, 2009, 2007
- Member, Strategic Grants Panel, NSERC, 2006–2009

### National and International Chemical Societies

- Past President, Canadian Society for Chemistry, 2013
- President, Canadian Society for Chemistry, 2012
- Vice–President, Canadian Society for Chemistry, 2011
- Vice–President, Inorganic Division, Canadian Society for Chemistry, 2011
- Director, Catalysis and Materials Divisions, CSC Board of Directors, 2002-2005
- Director, Catalysis and Materials Divisions, CSC Board of Directors, 1999-2002
- Member, Executive Committee, Fluorine Division, American Chemical Society 2002-2005
- Fellow, Chemical Institute of Canada
- Fellow, Royal Society of Chemistry UK
- Member, American Chemical Society and Chemical Society of Japan

### National and International Reviews

- Reviewer, Centers of Excellence, Germany
- Reviewer, Doctoral awards, Austria
- Reviewer, Faculty Candidates, Chemistry Department, University of Oulu, Finland, 2018
- Reviewer for tenure cases/promotions at Princeton University, University of Illinois at Urbana-Champaign, University of Michigan, University of Tokyo, University of Edinburgh, Manchester University, University of Saskatchewan, University of Alberta, University of British Columbia, and Dalhousie University.

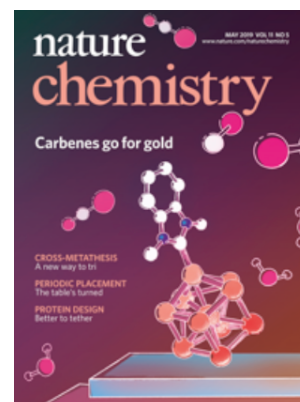
### Organization of Conferences and Symposia

- Vice-chair, Boron Americas, June 2016, Kingston
- Organizing Committee member, (one of two Canadian representatives) Pacificchem 2015, Hawaii
- Area convener, Inorganic Chemistry, Pacificchem 2015, Hawaii
- Symposium Organizer: N-Heterocyclic Carbene Complexes of the Transition Metals, Pacificchem 2015, Hawaii
- Vice-Chair, International Symposium on Homogeneous Catalysis, 2014, Ottawa
- Chair, Canada-Japan MEXT workshop, 2014, Ottawa
- Symposium Organizer: N-Heterocyclic and Mesoionic Carbenes in Catalysis, 97<sup>th</sup> Canadian Society for Chemistry Conference
- Symposium Organizer: Homogeneous and Heterogeneous Catalysis in Honour of Howard Alper, 95<sup>th</sup> Canadian Society for Chemistry Conference
- Organizing Committee member, Pacificchem 2010, Hawaii
- Area convener, Materials Chemistry, Pacificchem 2010, Hawaii
- Area coordinator, Materials Chemistry, Pacificchem 2005, Hawaii
- Co-organizer, Physical Organic Minisymposium, Queen's University, October 2004
- Conference Chair, 13<sup>th</sup> Quebec-Ontario Minisymposium in Organic and Bio-organic Chemistry, Queen's University, November 2002
- Symposium organizer: "Fluorine Chemistry" at the 84th National Canadian Society for Chemistry conference, Montreal, Que., May 2001
- Section organizer: "Homogeneous Catalysis" at the North American Catalysis Society Meeting, Toronto, Ontario, June 2001
- Symposium organizer: "Solids and Separation Science in Synthesis" at the 83rd National Canadian Society for Chemistry conference, Calgary, Ab., June 2000

### Research Interests

#### ***N-Heterocyclic carbene (NHC)-stabilized clusters.***

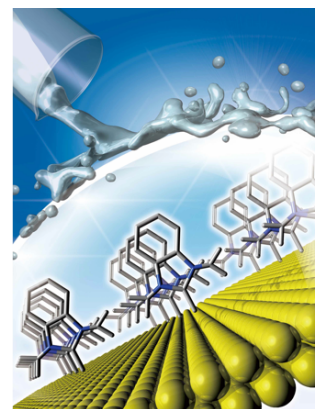
In papers 114 and 115 (***Nature Chemistry* 2019** and ***Jacs* 2019**), we describe the first examples of metallic nanoclusters protected by NHC ligands. Nanoclusters are a unique class of nanomaterial in that they are materials with size-dependent properties, but unlike related nanoparticles, they are atomically precise single molecules, while nanoparticles are conglomerates of similar-sized species. Nanoclusters are typically prepared with thiol ligands as surface ligands, with some



examples of phosphines. Neither of these ligands is perfect: thiol-based ligands exclusively protect clusters by surrounding them with a shell of oxidized Au species, and phosphines are weakly bound, limiting the stability of the resulting nanoclusters. NHCs are the best of both worlds, they keep the Au core in a metallic state, but bind with very strong bonds. These clusters have unique properties including the highest photoluminescence quantum yield ever recorded for nanoclusters.

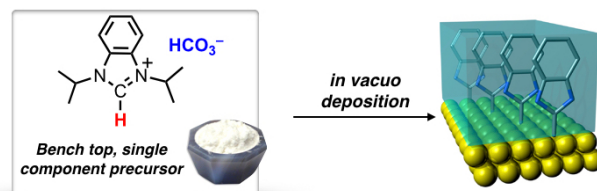
### ***Self-assembled NHC monolayers on gold.***

In paper 79, (***Nature Chemistry* 2014**), we described the first example of well-formed carbon-based monolayers on gold surfaces. Despite their widespread use in catalysis, N-heterocyclic carbenes (NHCs) have seen few applications in materials chemistry. In molecular transition metal complexes, they are known by their abilities to form strong metal–carbon bonds, making NHC complexes more resistant to heat and oxidation than typical complexes. With the assumption that these properties would translate to materials, we attempted the synthesis of self-assembled monolayers on gold and found that sterically unencumbered carbenes form monolayers that are significantly more stable than the state-of-the-art sulfur-based films. The NHC films are stable to high temperature, refluxing solvent, boiling acid, base and oxidation with dilute hydrogen peroxide. The work was called "game changing" and "the new gold standard" by international experts, and highlighted in chemistry and physics news magazines including ***Chemical and Engineering News*** (US), ***Physics Today*** (UK), ***Chemistry World*** (UK), ***Canadian Chemical News*** (CDN) and others.



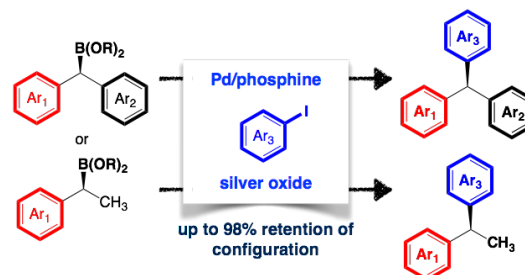
### ***Bench-stable precursors for self-assembled monolayer formation.***

In publication 94, (***Nature Communications* 2016**), the synthesis of a single component bench-stable precursor for use in the preparation of NHC films on metals was described. While our previous publication required inert atmosphere techniques and highly reactive chemicals, with this precursor, it is possible to prepare high quality films in air, without any special precautions. Films can also be deposited *in vacuo* without any solvents. With these easily formed films, we also demonstrated the formation of biosensors that were significantly more robust, reliable and sensitive than commercial biosensors.



### ***Stereoretentive Suzuki-Miyaura cross couplings.***

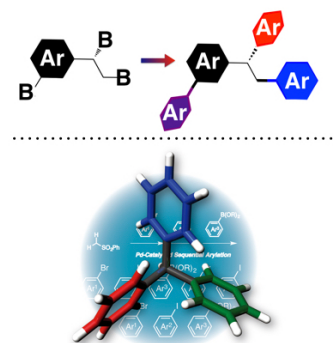
Our group has reported a substantial development in the Suzuki-Miyaura reaction (***Jacs* 2009 and 2014, and *ACIE* 2014**). This reaction is the number one reaction used in industry for the preparation of carbon-carbon bonds. Prior to our reports, the Suzuki-Miyaura reaction could only be used to make bonds with no stereochemistry, which is



a huge limitation since a significant number of pharmaceutical compounds are chiral. We have reported the first example of this reaction performed with chiral organoboron partners, proceeding with retention of chirality. Prior to this report, all coupling reactions of these systems failed or proceeded with loss of stereochemistry/chirality. The work has been used by other labs in the synthesis of two pharmaceutical agents, and has been highlighted in **Chemical and Engineering News**, and **Synfacts**, among others.

### ***Iterative Suzuki-Miyaura cross coupling of multiply borylated molecules.***

In our second **2016 Nature Communications paper** (#89), we reported the first example of iterative reaction of multiply functionalized organoboron compounds without any protecting group requirements. In addition, chiral compounds could be employed without loss of chirality. This discovery is currently under use in the automated robotic synthesis of organic molecules. This type of synthesis is employed in many other fields such as for the synthesis of genes and peptides, but has not been employed in the synthesis of small molecules in collaboration with the Burke group at UIUC.



### **Major Grants and Awards in Support of Research**

2019	Idea to Innovation (NSERC)	\$125,000
2019	Innovation for Defense Excellence and Security (Public Works)	\$160,000
2018-2020	Petroleum Research Fund	\$120,000
2017-2020	Japan Society for Promotion of Science (operating funds)	\$225,000
2016–2020	NSERC Discovery Grant (operating)	\$625,000
	<b>(highest nationally in 2016)</b>	
2015	CFI Innovation Fund/MRI-ORF (Crudden (PI) with 9 others)	\$8,823,520
2015–2016	Killam Research Fellowship	\$140,000
2014-2016	Japan Society for Promotion of Science	\$180,000
	Kakenhi (Grants-in-aid for Scientific Research) operating funds	
2014-2016	NSERC strategic grant, Crudden, (P.I.), Kraatz, Kennepohl,	
	Horton, J.H. and Albrecht, M. (international collaborator)	\$560,000
2014-2016	NSERC strategic grant, Mauzeroll, (P.I.), Crudden, and Horton	\$470,000
2013-2015	NSERC strategic grant, Stephan, D. (P.I.) and Crudden	\$472,000
2013	NSERC RTI (equipment grant)	\$122,000
2013-2014	American Chemical Society Petroleum Research Fund	\$100,000
2012-2014	NSERC strategic grant, Crudden (PI) and Westcott (Mt A)	\$270,000
2012-2014	NSERC strategic grant, Cunningham (PI) and Crudden	\$320,000
2010-2016	NSERC CREATE grant (chiral materials), Crudden (PI) and 9 others	\$1,600,000
2010-2015	NSERC Discovery grant (operating)	\$450,000
2010-2013	NSERC Discovery Accelerator Supplement	\$120,000
2010-2012	NSERC strategic grant (metal free reductions), Crudden (PI) and D. Stephan (Toronto)	\$465,000



2010	NSERC RTI (equipment grant)	\$117,000
2009-2011	NSERC strategic grant (chiral materials)	\$600,000
	Joint grant between Crudden (PI), Lemieux and Oleschuk	
2008-2009	NSERC strategic grant (hydrogen storage)	\$200,000
2008	CFI leaders opportunity fund (chiral materials)	\$736,000
	Joint grant between Lemieux (PI), Crudden and Loock	
2006-2009	NSERC strategic grant (metal sensing)	\$450,000
	Joint grant between Crudden (PI), Loock and Brown	
2007	NSERC RTI (equipment grant)	\$120,000
2006-2008	Merck Frosst Unrestricted Research Grant	\$75,000
2006-2008	Johnson and Johnson Focused giving grant	\$120,000
2006-2010	NSERC operating grant	\$300,000
2006	NSERC equipment grant	\$45,000
2006-2007	NSERC CRD grant (asymmetric synthesis)	\$44,000
2005-2006	NSERC CRD grant (fibre optics)	\$204,000
	Joint grant between Loock (PI), Crudden and Brown	
2005-2007	NSERC strategic grant (chiral materials)	\$375,000
	Joint grant between Crudden (PI), Lemieux and Sayari	
2004-2005	Merck Frosst Unrestricted Research Grant	\$50,000
2003	Premier's Research Excellence Award	\$100,000
2003	Chancellor's Research Award	\$50,000
2003	Merck and Company, Unrestricted Research Grant	\$40,000
2002	Canada Foundation for Innovation/Ontario Innovation Trust (Infrastructure) Joint grant with 7 others, Snieckus PI	\$7,455,800
2001-2006	NSERC (Operating)	\$262,500
2001-2002	NSERC (Collaborative Research and Development)	\$60,000
2001	NSERC (Infrastructure)	\$294,000
	Joint grant with 6 others, Crudden PI	
2001-2002	Pharmaceutical Consortium, Combi Chem grant	\$100,000
1999-2001	NSERC (Operating)	\$130,000
1999-2001	NSERC (Collaborative Research and Development)	\$69,000
1998	CFI New Opportunities Grant	\$112,766
1998-2002	Merck and Company, Unrestricted Research Grant	\$92,000
1998	Research Corporation, Research and Innovation Award	\$47,000
1997-1998	NSERC (Operating)	\$70,000

## Publications

121. M.R. Narouz, S. Takano, P.A. Lummis, T.I. Levchenko, A. Nazemi, S. Kaappa, S. Malola, S. Yousefalizadeh, L.A. Calhoun, K.G. Stamplecoskie\*, H. Häkkinen\*, T. Tsukuda\* and C.M. Crudden\*, "Robust, Highly Luminescent Au<sub>13</sub> Superatoms Protected by N-Heterocyclic Carbenes," **Journal of the American Chemical Society**, 2019, *in press*, DOI: 10.1021/jacs.9b07854
120. M. Nambo\*, J.C.H. Yim, L.B.O. Freitas, Y. Tahara, Z.T. Ariki, Y. Maekawa, D. Yokogawa, C.M. Crudden\* "Modular Synthesis of  $\alpha$ -fluorinated Arylmethanes via Desulfonative Cross-Coupling" **Nature Communications**, 2019, *in press*

119. D.-M. Yan, C.M. Crudden, J.-R. Chen, W.-J. Xiao, "A Career in Catalysis: Howard Alper", **ACS Catalysis**, **2019**, *7*, 6467-6483.
118. Y. Maekawa, Z.T. Ariki, M. Nambo, C.M. Crudden\* Pyridine-catalyzed Desulfonative Borylation of Benzyl Sulfones, **Organic and Biomolecular Chemistry**, **2019**, *17*, 7300-7303.
117. J.C.H. Yim, M. Nambo\*, Y. Tahara, C.M. Crudden\* "Copper-catalyzed Desulfonylative Cross-coupling of Benzhydryl Sulfones with Azoles", **Chemistry Letters**, **2019**, *48*, 975-977.
116. M.R. Narouz, K.M. Osten, P.J. Unsworth, R.W.Y. Man, K. Salorinne, S. Takano, R. Tomihara, S. Kaappa, S. Malola, C.-T. Dinh, J.D. Padmos, K. Ayoo, P.J. Garrett, M. Nambo, J.H. Horton, E.H. Sargent, H. Häkkinen\*, T. Tsukuda\*, C. M. Crudden\* "N-Heterocyclic Carbene-Functionalized Magic Number Gold Nanoclusters." **Nature Chemistry**, **2019**, *11*, 419-425.
115. C.A. Smith, M. Narouz, P.A. Lummis, I. Singh, A. Nazemi, C.-H. Li, C.M. Crudden\*, "N-Heterocyclic Carbenes in Materials Chemistry." **Chemical Reviews**, **2019**, *119*, 4986-5056.
114. M. Nambo\*, Y. Tahara, J.C.-H. Yim, C.M. Crudden\* "Cu-Catalyzed Desulfonative Amination of Benzhydryl Sulfones." **Chemistry A European Journal**, **2019**, *25*, 1923-1926.
113. H. Chen, J. Saunders, S. Borijan, X. Wu, C.M. Crudden, D.-X. Xu, H.-P. Look\* "Microresonators: Tetrasulfide-Functionalized Mesoporous Silica on Nanowire Ring Resonators for Detection of Aqueous Lead, Pb(II)" **Advanced Sustainable Systems**, **2019**, *3*, 1800084.
112. O.L. Torres-Rocha, X. Wu, C.Y. Zhu, C.M. Crudden, M.F. Cunningham\*, "Polymerization-Induced Self-Assembly (PISA) of 1,5-Cyclooctadiene Using Ring Opening Metathesis Polymerization" **Macromolecular Rapid Communications**, **2019**, *40*, 1800326.
111. C.Y. Zhu, X. Wu, O. Zenkina, M.T. Zamora, K. Moffat, C.M. Crudden\*, M.F. Cunningham\*, "Ring-Opening Metathesis Polymerization in Miniemulsion Using a TEGylated Ruthenium-Based Metathesis Catalyst." **Macromolecules**, **2018**, *51*, 9088-9096.
110. Y. Zeng, T. Zhang, M. Narouz, C.M. Crudden\*, P.H. McBreen\*, "Generation and Conversion of an N-Heterocyclic Carbene on Pt(111)." **Chemical Communications**, **2018**, *54*, 12527-12530.
109. Z. Li, K. Munro, M.R. Narouz, A. Lau, H. Hao, C.M. Crudden, J.H. Horton\* "Self-Assembled N-Heterocyclic Carbene-Based Carboxymethylated Dextran Monolayers on Gold as Tunable Platform for Designing Affinity-Capture Biosensor Surfaces." **ACS Applied Materials & Interfaces**, **2018**, *10*, 17560-17570.
108. L. Stephens, J. D. Padmos, M. Narouz, A. Al-Rashed, C.-H. Li, N. Payne, M.T. Zamora, C.M. Crudden\*, J. Mauzeroll\*, J.H. Horton\*, "The Structural and Electrochemical Effects of N-Heterocyclic Carbene Monolayers on Magnesium." **Journal of the Electrochemical Society**, **2018**, *165*, G139-G145.
107. Z.T. Ariki, Y. Maekawa, M. Nambo, C.M. Crudden\*, "Preparation of Quaternary Centers via Nickel-Catalyzed Suzuki-Miyaura Cross-Coupling of Tertiary Sulfones." **Journal of the American Chemical Society**, **2018**, *140*, 78-81.
106. R.W.Y. Man, C.-H. Li, M.W.A. MacLean, O.V. Zenkina, M.T. Zamora, L.N. Saunders, A. Rousina-Webb, M. Nambo and C.M. Crudden\*, "Ultra Stable Gold Nanoparticles



- Modified by Bidentate N-Heterocyclic Carbene Ligands." ***Journal of the American Chemical Society***, **2018**, *140*, 1576-1579.
105. J.J. Clarke, P. Eisenberger, S.S. Piotrkowski and C.M. Crudden. "Azaborines: Synthesis and Use in the Generation of Stabilized boron-substituted carbocations," ***Dalton Transactions***, **2018**, *47*, 1791-1795.
  104. Z. Li, M.R. Narouz, K. Munro, B. Hao, C.M. Crudden, J.H. Horton, H. Hao "Carboxymethylated Dextran-Modified N-Heterocyclic Carbene Self-Assembled Monolayers on Gold for Use in Surface Plasmon Resonance Biosensing." ***ACS Applied Materials & Interfaces***, **2017**, *9*, 39223-39234.
  103. J.P.G. Rygus, C.M. Crudden\*, "Enantiospecific and Iterative Suzuki-Miyaura Cross-Couplings." ***Journal of the American Chemical Society***, **2017**, *139*, 18123.
  102. C.R. Larrea, C.J. Baddeley\*, M.R. Narouz, N.J. Mosey, J.H. Horton\*, C.M. Crudden\*, "N-Heterocyclic Carbene Self-assembled Monolayers on Copper and Gold: Dramatic Effect of Wingtip Groups on Binding, Orientation and Assembly." ***ChemPhysChem.***, **2017**, *18*, 3536-3539.
  101. M.R. Narouz, C.-H. Li, A. Nazemi, C.M. Crudden, "Amphiphilic N-Heterocyclic Carbene-Stabilized Gold Nanoparticles and their Self-Assembly in Polar Solvents," ***Langmuir***, **2017**, *33*, 14211-14219.
  100. Z. Li, K. Munro, I. Ebralidze, J.D. Padmos, M.R. Narouz, H. Hao, C.M. Crudden and J.H. Horton, "N-Heterocyclic Carbene Self-Assembled Monolayers on Gold as Surface Plasmon Resonance Biosensors," ***Langmuir***, **2017**, *33*, 13936-13944.
  99. M. Nambo\*, J. Yim, K. Fowler, C.M. Crudden\*, "Synthesis of Tetraarylmethanes by the Triflic Acid-Promoted Formal Cross Dehydrogenative Coupling of Triarylmethanes with Arenes." ***Synlett***, **2017**, *28*, 2930-2940.
- \*Chosen as top paper of the year**
98. M. Nambo, J. Yim, C.M. Crudden, "Pd-Catalyzed Desulfonative Cross-Coupling of Benzylic Sulfone Derivatives with 1,3-Oxazole," ***Organic Letters***, **2017**, *19*, 3715-3718.
  97. K. Salorinne, R.W.Y. Man, C.-H. Li, M. Taki, M. Nambo\* and C.M. Crudden\* "Water Soluble N-Heterocyclic Carbene-Protected Gold Nanoparticles: Synthesis, Stability and Optical Properties", ***Angewandte Chemie International Edition***, **2017**, *56*, 6198-6202.
  96. P. Eisenberger\*, C.M. Crudden\* "New, Potentially Chelating NHC Ligands; Synthesis, Complexation Studies, and Preliminary Catalytic Evaluation", ***Dalton Transactions***, **2017**, *46*, 4874-4887.
  95. M. Nambo\*, E.C. Keske, J.P.G. Rygus, J. Yim, C.M. Crudden\* "Development of Versatile Sulfone Electrophiles for Suzuki–Miyaura Cross-Coupling Reactions", ***ACS Catalysis***, **2017**, *7*, 1108–1112.
  94. C.M. Crudden\*, J.H. Horton\*, M.R. Narouz, Z. Li, C.A. Smith, K. Munro, C.J. Baddeley, C.R. Larrea, B. Drevniok, B. Thanabalasingam, A.B. McLean, O.V. Zenkina, I.I. Ebralidze, Z. She, H.-B. Kraatz, N.J. Mosey, L.N. Saunders, A. Yagi, "Simple direct formation of self-assembled N-heterocyclic carbene monolayers on gold and their application in biosensing", ***Nature Communications***, **2016**, *7*, 12654.
  93. J. Lam, B.A.R. Günther, J.M. Farrell, P. Eisenberger,\* B.P. Bestvater, P.D. Newman, R.L. Melen\*, C.M. Crudden\*, D.W. Stephan\* "Chiral Carbene–Borane Adducts: Precursors for Borenum Catalysts for Asymmetric FLP Hydrogenations," ***Dalton Transactions***, **2016**, *45*, 15303-15316.

92. L.M. Reid, C.M. Crudden\*, "Stable molecular chirality within the walls of periodic mesoporous organosilicas via chiral induction," **Chemistry of Materials**, **2016**, *28*, 7605–7612.
91. M. Nambo\*, Z.T. Ariki, D. Canseco-Gonzalez, D. Beattie, C.M. Crudden\* "Arylative Desulfonation of Diarylmethyl Phenyl Sulfones with Arenes Catalyzed by Scandium Triflate", **Organic Letters**, **2016**, *18*, 2339.
90. L.M. Reid, G. Wu, C.M. Crudden\*, "Accessible bidentate diol functionality within highly ordered composite periodic mesoporous organosilicas", **New Journal of Chemistry**, **2016**, *40*, 6487-6497.
89. C.M. Crudden\*, C.A. Ziebenhaus, J.P.G. Rygus, K. Ghazati, P.J. Unsworth, M. Nambo, S. Voth, M. Hutchinson, V. S. Laberge, Y. Maekawa, D. Imao, "Iterative, Protecting Group-free Cross-Coupling Leading to Chiral, Multiply Arylated Structures" **Nature Communications**, **2016**, *7*, 11065.
88. I.R. Nemitz, K. McEleney, C.M. Crudden, R.P. Lemieux, R.G. Petschek, C. Rosenblatt\*, "Chiral Periodic Mesoporous Organosilica in a Smectic-A Liquid Crystal: Source of the Electrooptic Response" **Liquid Crystals**, **2016**, *43*, 497-504.
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## HQP Training and Mentoring

### Current group: CANADA

HQP	Scholarships and Awards	Travel Experience
Mina Narouz (PhD)	OGS award, Queen Elizabeth II graduate scholarship, CREATE graduate award Mitacs JSPS fellowship NSERC Postdoctoral Fellowship	Nagoya University (research exchange) Saskatoon (CLS), Quebec City, Toronto, Ottawa (CSC) Hokkaido, Japan Tokyo, Japan (research exchange)

Joshua Clarke (PhD)	NSERC CGSM OGS award ITA award (Queen's) Huntley award	Quebec City (CSC) Halifax (CSC) Toronto (CSC) <i>Oxford (research exchange)</i>
Zach Ariki (PhD)	OGS award ITA award (Queen's) Huntley award Mohan award Top Presentation Award (IDW)	Quebec City, Edmonton, Toronto (CSC) <i>Salt Lake City, Utah (research exchange)</i> <i>Nagoya Japan (ITbM Nagoya research exchange)</i>
Alex Veinot (PhD)	Martha Hall Vanderpoel Mills Memorial Scholarship Robert Sutherland Fellowship Maritimes & Northeast Pipeline Scholarship	Quebec City (CSC)
Emily Albright (PhD)	Karel Wiesner Postgraduate Scholarship William and Lois Paine Founder's Scholarship	Quebec City (CSC)
Ishwar Singh (PhD)	QGA Fellowship (Queen's)	Edmonton, Toronto (CSC)
Dianne Lee (MSc)	QGA Fellowship (Queen's)	Quebec City, Toronto (CSC)
Nicole Dozois (MSc)	QGA Fellowship (Queen's)	
Angus Sullivan (MSc)	Makhija Prize in Chemistry Department of Physics Prize Dean's Honour Roll Trent National Scholarship Bruce Barrett Memorial Prize	
Dr. Paul Lummis (PDF)	PhD from University of Alberta	
Dr. Yuuki Maekawa (PDF)	<i>JSPS Postdoctoral Fellowship</i> PhD from Gifu University, Japan	
Dr. Tanya Levchenko (PDF)	<i>NSERC Postdoctoral Fellowship</i> PhD from Western University	
Dr. Hridaynath Bhattacharjee (PDF)	PhD from University of Saskatchewan	
Dr. Srijit Nair (PDF)	PhD from Queen's University, Chemical Engineering	
Dr. Karthik Devaraj (PDF)	PhD from Uppsala, Sweden	

### Current group: JAPAN

HQP	Scholarships and Awards	Country/School of origin
Dr. Jacky Yim PDF	JSPS Postdoctoral Fellow, NSERC PGSD GE Laird Research Fellowship UBC Faculty of Science Graduate Award	Canada, UBC
Dr. Renee Man PDF	UBC Faculty of Science Graduate Award FJ Nicholson Scholarship	Canada, UBC
Dr. Kim Osten PDF	NSERC/JSPS Postdoctoral Fellows	Canada, UBC

### Accomplishments of Selected Former Group Members

*Eric Keske, PhD*, Selected as one of 45 Reaxys Prize finalists world-wide  
currently NSERC Postdoctoral fellow at U Edinburgh (Scotland)

*Tomohiro Seki, PhD*, Takeda Pharmaceuticals, Yokohama (Japan)

*Steven Dickson, PhD*, Research Project Lead, Imperial Oil (Canada)  
*Jonathan Webb, PhD*, Research Project Lead, Imperial Oil (Canada)  
*Jenny Du, PhD*, Director, Apeel Sciences, California (USA)  
*Jeremy Praetorius, PhD*, Research Scientist, Chevron Oil, Oklahoma (USA)  
*Daryl Allen, PhD*, Product Development Manager, Materia, California (USA)  
*Ren Li, PhD*, Senior Research Investigator, Array BioPharma, Boulder, Colorado (USA)  
*Austin Chen, PhD*, Scientist Inception Sciences, California (USA)  
*Olena Zenkina, Former PDF*, Assistant Professor, University of Ontario Institute of Technology (Canada)  
*Stephanie MacQuarrie, Former PDF*, Professor, University of Cape Breton (Canada)  
*Kazunori Hirabayashi, Former PDF*, Professor, Tokyo Metropolitan University (Japan)  
*Daniel Canseco-Gonzalez, Former PDF*, Research Scientist, BASF (Mexico)  
*Daisuke Imao, Former PDF*, Research Scientist, Evonik (Japan)  
*Kazuhiko Semba, Exchange PhD*, Assistant Professor, Kyoto University (Japan)  
*Yoichi Hoshimoto, Exchange PhD*, Assistant Professor, Osaka University (Japan)  
*Takuji Kawamoko, Exchange PhD*, Assistant Professor, Yamaguchi University (Japan)

## Invited Lectures

- 2019.** Core to Core symposium (Plenary, Nagoya University); University of British Columbia; Simon Fraser University; Université Claude Bernard Lyon 1, France; ERATO Molecular Science Symposium (Nagoya University); 257<sup>th</sup> ACS National Meeting (Orlando, 2 invited lectures); 102<sup>nd</sup> Canadian Society for Chemistry Conference (Quebec City, three invited lectures); 258<sup>th</sup> ACS National Meeting (San Diego); Inorganic Discussion Weekend (Plenary speaker, Oshawa); Japan–US Science forum, Harvard; University of New Brunswick; St. Mary's University; Dalhousie University; Rutgers University; Chemical Science Symposium on Organic Materials, London, England
- 2018.** Western University (student selected seminar); Münster University Core-to-Core symposium; 255<sup>th</sup> ACS National Meeting (New Orleans, two invited talks), Southwestern Ontario Undergraduate Chemistry Conference, Plenary speaker (Waterloo); 25<sup>th</sup> Canadian Symposium on Catalysis, Plenary speaker/award lecture (Saskatoon); 101<sup>st</sup> Canadian Society for Chemistry annual conference (Edmonton, two invited talks); Gilead Sciences Inc. (Edmonton); International Precious Metals Institute annual conference, Plenary speaker/award lecture (San Antonio); Boron in the Americas XVI (Boston); Stereochemistry Gordon Research Conference Newport Rhode Island; 43<sup>rd</sup> International Conference on Co-ordination Chemistry, keynote lecture (Sendai, Japan); American Vacuum Society, 65<sup>th</sup> international symposium, Long Beach California; International Kyoto Conference on Organic Chemistry (Kyoto, Japan).
- 2017.** Simon Fraser University; University of British Columbia; University of Victoria; University of Calgary; Laval University; 100<sup>th</sup> Canadian Society for Chemistry conference (two invited talks); 12<sup>th</sup> International Conference for Heteroatom Chemistry (Vancouver); International Symposium on Monolayer Protected Clusters (Monte Verita); University of Zurich; University of Basel; University of Fribourg; University of Bern; University of Geneva; ETH Zurich.
- 2016.** University of Alberta; University of Toronto; 251<sup>st</sup> ACS National Meeting (San Diego); Carleton University; 252<sup>nd</sup> ACS National Meeting (Philadelphia); IRTG Symposium, Münster, Germany; Plenary speaker, 24<sup>th</sup> Canadian Symposium on Catalysis (Ottawa); 7<sup>th</sup> annual Green Chemistry & Catalysis meeting (McGill); 15<sup>th</sup> Boron in the Americans Conference (Kingston); Mount Allison University; University of New Brunswick; Dalhousie University; Vertex Pharmaceuticals; Laval University; 4<sup>th</sup> International

- Symposium on New Frontiers in Materials Science, Hokkaido; International Symposium on Catalysis and Fine Chemicals, Taiwan; ITbM International Symposium, Nagoya.
- 2015.** Two Gordon Research Conferences (Organic Reactions and Processes and Inorganic Reaction Mechanisms, latter as discussion leader); American Vacuum Society meeting (California); Pacifichem 2015 (Honolulu, two invited talks); 18<sup>th</sup> Organometallic Chemistry Directed Towards Organic Synthesis (Sitges, Spain); 98th Canadian Society for Chemistry conference (two invited talks); International Symposium on Monolayer Protected Clusters (Tokyo); Joint IBS-KAIST/ITbM Symposium (Seoul)
- 2014.** Oxford University; International Symposium on Homogeneous Catalysis, **Plenary Lecturer, Tateshina Conference** (Japanese Gordon Conference), **Aldrich Endowed Lecture**, University of Michigan; 19th International Symposium on Homogeneous Catalysis, Ottawa; Bristol University; **Fagnou Lecturer**, Ottawa University; Edinburgh University; University of Illinois at Urbana Champaign, **Organic Reactions Lecturer**; Queen's Nanoscience Symposium, **Plenary Lecturer**
- 2013.** Princeton University; **Beckman Scholars Symposium**, California; Chemical Society of Japan Annual Meeting, Canada-Japan Symposium, Ritsukumen, Japan; 245th ACS National Meeting, Award symposium in honour of Melanie Sanford, New Orleans; 1st International Conference, Institute of Transformative Bio-Molecules, (Nagoya, Japan); 96th Canadian Society for Chemistry Conference, (Quebec City); 15th Asian Chemistry Congress, Singapore; Kyoto University, Katsura Campus; University College Dublin; Toyota Research Labs, Nagoya; Nagoya University, Kyoto University.
- 2012.** Toyota Research Labs, Nagoya; Nagoya University; Kyoto University; Institute for Chemical Research; Kyoto University Uji Campus; Osaka University; Dalhousie University; 244<sup>th</sup> ACS National Meeting, NHC symposium, (Philadelphia); University of Minnesota; University of Iowa; 95<sup>th</sup> Canadian Society for Chemistry National Meeting (Calgary); CSC Catalysis Conference (Quebec City)
- 2011.** **Distinguished Female Lecturer, Stanford University**; California Institute of Technology; 241<sup>st</sup> ACS National Meeting, Anaheim; "Award symposium in honour of Jeffrey Bode"; 94<sup>th</sup> Canadian National Conference (Montreal); York University; Concordia University; Mount Allison University
- 2010.** 93<sup>rd</sup> Canadian National Conference (Toronto); University of New Brunswick (Fredericton); University of Cape Breton; Acadia University; "Catalysis and Chirality in Molecules and Materials" 23<sup>rd</sup> Jacques Cartier Center Colloquium: Catalysis Science at the Dawn of the 21st Century (Lyon, France); Pacifichem 2010 (Hawaii, three invited lectures)
- 2009.** 92<sup>nd</sup> Canadian National Conference (Hamilton); 237<sup>th</sup> American Chemical Society annual conference, "Organoboron Chemistry" symposium; BASF Boron Conference; Organic Reactions and Processes; Gordon Research Conference, discussion group leader
- 2008.** Summer Organic Chemistry Conference, Memorial University of Newfoundland, **Plenary lecturer**; Junior Nanotechnology Network, McGill University, **Plenary Lecturer**; Organic Reactions and Processes, Gordon Research Conference, invited speaker
- 2007.** Global Center of Excellence Lecturer, Waseda University, **Plenary Lecturer**; Physical Organic Gordon Research Conference, invited speaker
- 2006.** 17<sup>th</sup> International Symposium on Homogeneous Catalysis (Sun City, South Africa); 16<sup>th</sup> IUPAC International Conference on Organic Synthesis (Merida, Mexico); 21<sup>st</sup> COE International Conference (Nagoya, Japan)
- 2005.** Emerging Materials Knowledge Workshop, (Sudbury) **Plenary Speaker**; 88<sup>th</sup> National

Canadian Society for Chemistry conference (Saskatoon); Maritime Inorganic Discussion Weekend, (Sackville) **Plenary speaker**

- 2004.** 227<sup>th</sup> American Chemical Society annual conference, symposium on "N-Heterocyclic Carbene Chemistry"; 87<sup>th</sup> National Canadian Society for Chemistry conference (London); NSF workshop for Synthetic Organic Chemistry, invited speaker (one of 15 invitees); Stereochemistry Gordon Research Conference, invited speaker; Organic Reactions and Processes, Gordon Research Conference, invited speaker; Facilitated Chemical Synthesis, Gordon Research Conference, invited speaker
- 2003.** Quebec-Ontario Minisymposium on Organic/Bioorganic Chemistry (Montreal); 39<sup>th</sup> IUPAC conference/86<sup>th</sup> Canadian Society for Chemistry conference (Ottawa); Heterocycles Gordon Research Conference, invited speaker
- 2002.** Natural Products, Synthesis and Chirality Conference (Dalhousie) **Plenary speaker**; 85<sup>th</sup> National Canadian Society for Chemistry conference, (Vancouver); 17<sup>th</sup> National meeting, Canadian Catalysis Society, Vancouver); **Plenary speaker**; Organic Reactions and Processes Gordon Research Conference, invited speaker
- 2001.** 222<sup>nd</sup> American Chemical Society meeting, symposium on "Molecular Engineering for Phase Separable Catalysis" (San Diego)
- 2000.** 83<sup>rd</sup> National Canadian Society for Chemistry conference (Calgary)
- 1999.** 82<sup>nd</sup> National Canadian Society for Chemistry conference (Toronto)

## Outreach

Interview with Kit Chapman, *Chemistry World*

Interview with Mark Peplow, *Nature Reviews Chemistry*

Interview with Vivien Gandolfi, *Queen's Chemistry Department Student Council*

Interviews with Alan Neal, *CBC All in a Day* (Iridium and Palladium)

<https://www.cbc.ca/player/play/1434035779679>

<https://www.cbc.ca/listen/shows/all-in-a-day/segment/15668264>

Interview with Ben Charland, *What on Earth is Going on?*

<http://woegoshow.com/with-chemistry-ep-41>

Interviews with *Chemistry World*

<https://www.chemistryworld.com/news/earth-abundant-metal-catalyst-activation-made-simple/2500239.article>

<https://www.chemistryworld.com/news/carbene-monolayer-technology-on-a-roll/1017503.article>

<https://www.chemistryworld.com/news/canadas-research-council-is-open-for-business/6167.article>

<https://www.chemistryworld.com/news/carbenes-beat-thiols-for-robust-monolayers/7211.article>

Interviews with *Chemical & Engineering News*

<http://cen.acs.org/articles/93/i11/Machine-Automates-Assembly-Small-Molecules.html>

<https://cen.acs.org/content/cen/articles/95/i11/Foreign-students-postdocs-US-worry-about-the-future.html>

<https://cen.acs.org/content/cen/articles/94/i30/Boron-chemistry-branches.html>

Interviews with *Queen's Gazette*



<http://queensu.ca/gazette/stories/16-million-boost-research>  
[http://www.queensu.ca/gazette/stories/research-partnership-expands-queen-s-links-japan?utm\\_source=e-queens-gazette\\_optin](http://www.queensu.ca/gazette/stories/research-partnership-expands-queen-s-links-japan?utm_source=e-queens-gazette_optin)  
[http://www.queensu.ca/gazette/stories/province-injects-16-million-queen-s-research?utm\\_source=e-queens-gazette\\_staff](http://www.queensu.ca/gazette/stories/province-injects-16-million-queen-s-research?utm_source=e-queens-gazette_staff)

Interview with *Science Magazine*

<http://www.sciencemag.org/content/347/6227/1190.full.pdf>

Interview on the Synlett best paper award 2017

<https://www.thieme.de/en/thieme-chemistry/interview-with-synlett-best-paper-award-winners-cathleen-crudden-and-masakazu-nambo-131196.htm>

Interview with Science Daily

<https://www.sciencedaily.com/releases/2011/07/110721131159.htm>

Interview on the Beckman Program

<https://www.youtube.com/watch?v=dp0XUAen4xw>

Interview with Phys Org

<https://phys.org/news/2016-09-carbon-coating-strength-medical-instruments.html>