

4th-Year Chemistry Thesis Projects 2020-2021 Academic Year

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Application for Thesis Information and Instructions

NOTE re Coronavirus Lockdown: Due to the disruptions caused by the Campus closure, the Thesis Application Deadline has been extended to May 10th 2020; note also that, while it is currently assumed that lab work will be able to resume in Sept 2020, the Honours thesis projects may be subject to postponement from an extended closure and/or changes to accommodate future restrictions related to the Coronavirus outbreak.

Introduction

The thesis option consists of two courses: CHEM 4410U and CHEM 4420U. Each course constitutes 3 credit hours of the 120 credit hours required for an honours degree. Students are expected to enroll and pass CHEM 4420U immediately following CHEM 4410U. Under most circumstances, these courses will be taken in the fall and winter semesters of the student's final academic year.

The completion of the honours thesis is expected to require at least 230 hours of work on the part of the student (i.e., an average of 9 hours per week in each of the two semesters). The majority of this time will be spent in the laboratory conducting original research under the supervision of a faculty member. The evaluation of the chemistry honours thesis will be based on three components: i) in-lab performance; ii) oral defence of the thesis; iii) written dissertation. Both the student and the faculty supervisor should familiarize themselves with policies and procedures governing the honours thesis. These guidelines should not be interpreted as superseding any regulations described in the university calendar or general policies of the Faculty of Science.

Qualification for the Honours Thesis

To qualify for the honours thesis in chemistry a student must:

1. Have completed 90 credit hours toward their degree by the beginning of the fall semester of the year in which they intend to take CHEM 4410U / 4420U.
2. Have a GPA of 2.0 and be in clear academic standing.
3. Have passed at least four of: CHEM 3040U, CHEM 3120U, CHEM 3220U, CHEM 3520U and CHEM 3540U.

Students who have not completed 90 credit hours at the end of their third-year may be admitted provisionally to CHEM 4410U if they can show that they will have completed 90 credit hours by the start of the fall semester.

Selection of a Project

Each year faculty members in the Faculty of Science willing to supervise undergraduate theses in chemistry will provide a list of thesis projects from which a student may choose. Normally, a student completing a program in chemistry will do a project under

the supervision of one of the chemistry faculty members. However, projects from other disciplines (or even other Faculties) may also be acceptable as long as the research involves significant chemistry content. Such projects require the approval of the Chemistry Undergraduate Studies Committee.

Students may apply to work on a project by completing the “Honours Thesis Application” form available on the Faculty of Science website. The completed form is submitted by email to the current Undergraduate Program Director (UPD) for Chemistry (kevin.coulter@ontariotechu.ca in 2020). Acceptance by an individual supervisor is not guaranteed and is at the sole discretion of the supervisor. Students must apply to work on a project by **May 10th for 2020 (normally April 30th)** of the year prior to starting the research project. The UPD will inform students asap (by May 30th at the latest) if they have been selected by a supervisor and are approved to register in CHEM 4410U/4420U.



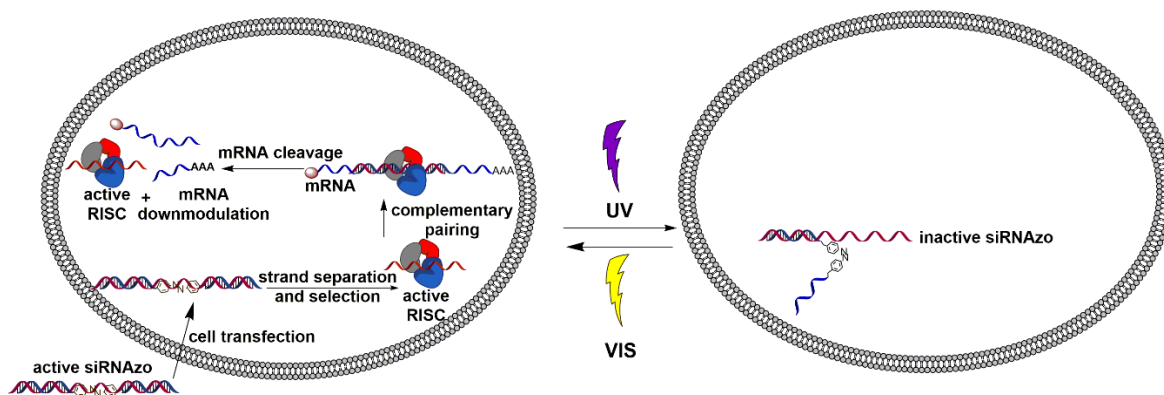
Professor Jean-Paul Desaulniers, Associate Professor – Research Profile

The Desaulniers research group in Chemical Biology uses tools of organic chemistry, biochemistry, biophysical chemistry, and molecular biology to target, probe, and understand various components of gene expression. Organic chemistry is a powerful research tool for biology, because it allows us to answer key questions of biological importance. Diverse projects in our group range from the use of synthetic organic chemistry to generate new molecules with potential beneficial properties, to cell-based biological characterization of macromolecular-ligand interactions.

Research Projects for Chemistry Students for the 2020-2021 Academic Year

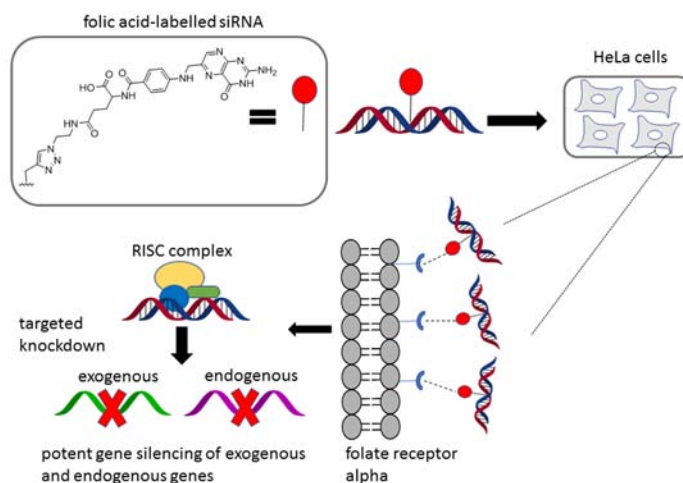
Project 1. Chemical Synthesis of Photoswitchable siRNAs

In this project, an undergraduate exchange student will work closely with a senior PhD student aimed at synthesizing new types of chemically-modified short-interfering RNAs that have photoresponsive properties. Through the use of organic chemistry, the student will synthesize phosphoramidite building blocks, and synthesize RNAs on solid-phase resin. This multi-disciplinary project will expose the exchange student to wide range of experimental techniques in a state-of-the art laboratory.



Project 2. Synthesis of Folic-Acid Derivative Phosphoramidites for Nucleic Acids

Recently, we have identified that folic-acid tagged siRNAs are excellent vectors for delivery of siRNAs into cells. To improve the synthetic utility of the chemistry, we are investigating the synthesis of folic acid phosphoramidites, that could allow for facile site-specific incorporation into a library of oligonucleotides. The student working on this project will be exposed to organic chemistry, and solid-phase synthesis.



Selected Publications (students bolded)

- 1) **M. L. Hammill**, G. Islam, and J.-P. Desaulniers. "Reversible Control of RNA Interference by siRNAzOs" *Org. Biomol. Chem.* **2020**, *18*, 41-46.
- 2) **L. Salim**, G. Islam, and J.-P. Desaulniers. "Targeted Delivery and Enhanced Gene-Silencing Activity of Centrally-Modified Folic Acid-siRNA Conjugates" *Nucleic Acids Res.* **2020**, *48*, 75-85.
- 3) **M. L. Hammill**, **A. Patel**, **M. A. Alla**, and J.-P. Desaulniers. "Stability and Evaluation of siRNAs Labeled at the Sense Strand with a 3'-Azobenzene Unit" *Bioorg. Med. Chem. Lett.* **2018**, *28*, 3613-3616.
- 4) **L. Salim**, **C. McKim**, and J.-P. Desaulniers. "Effective Carrier-Free Gene-Silencing Activity of Cholesterol-Modified siRNAs" *RSC Advances* **2018**, *8*, 22963-22966.
- 5) **B. J. Peel**, **G. Hagen**, **K. Krishnamurthy**, and J.-P. Desaulniers. "Conjugation and Evaluation of Small Hydrophobic Molecules to Triazole-Linked siRNAs" *ACS Med. Chem. Lett.* **2015**, *6*, 117-122.

More information: Visit <http://jpdessaulniers.com>

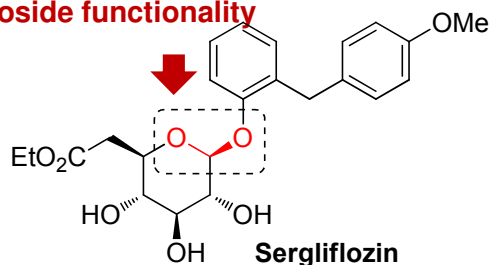
Dr. Yuri Bolshan

Associate Professor

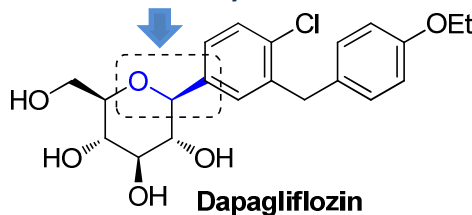
Pharmaceutical/Synthetic Organic Chemistry
Science Building, Room 4070



Natural but unstable
O-glycoside functionality



Unnatural and stable
C-glycoside functionality



Increased chemical and metabolic stability

vs
Intravenous vs Oral therapy

OUR RESEARCH

Incorporation into anticancer drugs to improve their pharmacological properties.
Emphasis: antileukemic drugs

Development of methodologies for the synthesis of unnatural C-glycosides and β - and γ -amino acids

γ -amino acids are known neurotransmitters
Emphasis: Huntington's disease
Parkinson's disease, pain

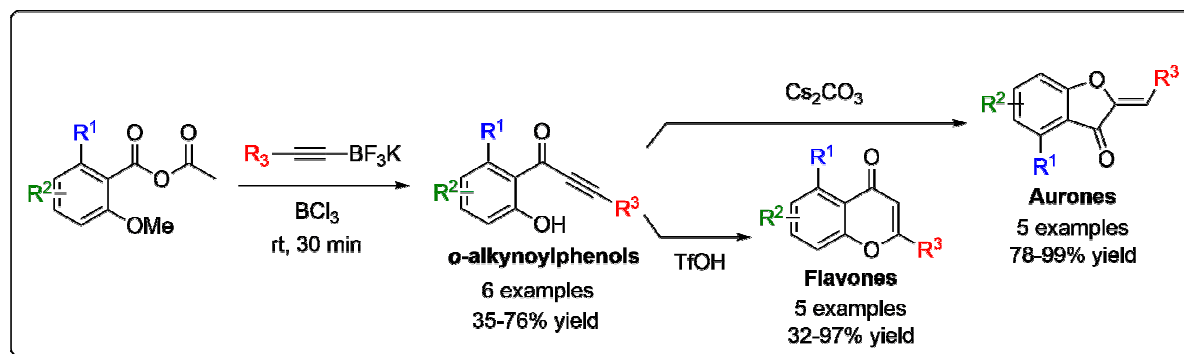
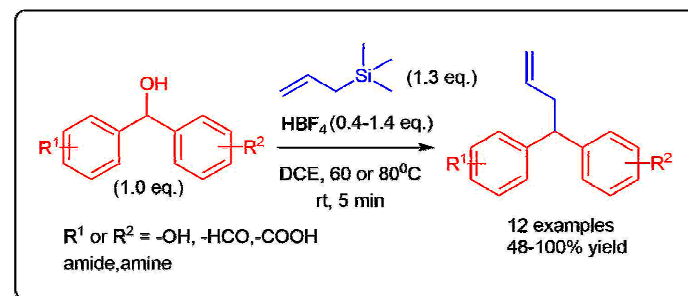
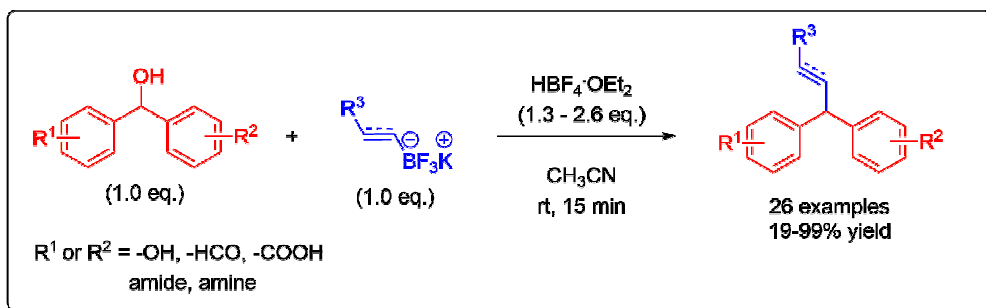
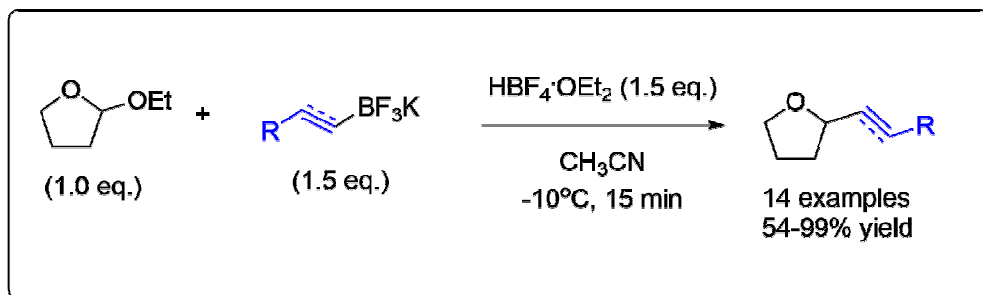
Synthesis of inhibitors for epigenetic proteins that modify DNA and control genes' expression

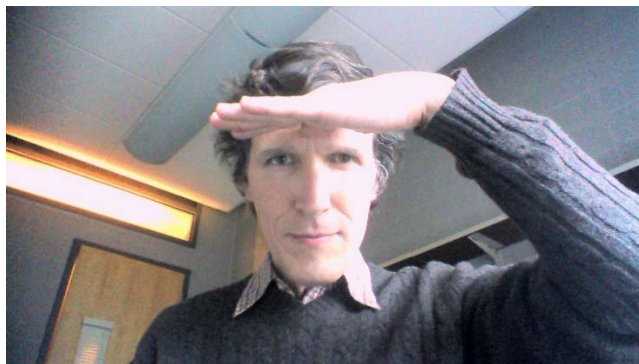
β -amino acids are metabolically more stable than α -amino acids
Emphasis: synthetic analogs of natural antibiotics

Dr. Yuri Bolshan

Associate Professor

Pharmaceutical/Synthetic Organic Chemistry
Science Building, Room 4070





Professor Fedor Naumkin, Associate Professor – Research Profile

The Naumkin's Computational Nanochemistry research group deals with prediction and design of new nanosystems (atomic/molecular complexes, junctions and interfaces), investigation of their structures, properties, and their inter-relationships. Of specific current interest are novel systems with molecules:

- (1) trapped between counter-ions and stimulated to isomerise/react, or
- (2) linked by metals into assemblies with controllable shape alterations.

Such species could have various applications including building blocks for new materials with desired properties, light detection and utilization, molecular electronics and machinery, efficient energy storage at molecular level, molecular self-assembly, new type of induced reactions, etc.

Project 1. Modelling of highly polar supramolecular species and induced reactions in them.

Project 2. Design of molecule-metal complexes with charge- and spin-controlled geometries.

The student will computationally investigate a series of novel complexes of molecules inserted into ion-pairs or connected to metal atoms. These systems will be suitably built based on the molecular geometries, their structures will be optimized in terms of energy, and their stability, polarity, IR spectra, reactivity and other properties will be analysed.

Project 1 will focus on enhanced polarity and IR spectra, both being sensitive to the system structure. Next, reaction-barrier evolution inside the complex due to the combined mechanical pressure and electric field of the ions will be studied. The reactants and reactions will be identified via unique IR signatures.

Project 2 will concentrate on the development of stable junctions between metal atoms and in/organic molecules. Next, the system behaviour in ionic and electronically-excited states will be studied, to evaluate feasibility of charge/excitation-induced manipulations of its shape and related characteristics.

In either project the student will acquire practical experience of working with state-of-the-art quantum-chemistry software and visualization tools, using high-performance computing facilities accessible at and through the UOIT. The results are expected to be published in high-rank scientific journals.

Selected publications with undergraduate students

- 1) M. Sullivan* and F. Y. Naumkin, Exploring the effects of ion-pair trapping on IR spectra and isomerization of polar molecules. To be published (2020).
- 2) S. Kerr* and F. Y. Naumkin, Noncovalently bound complexes of polar molecules: Dipole-inside-of-dipole vs dipole-dipole systems. *New J. Chem.* 41 (2017) 13576.
- 3) B. Cochrane* and F. Y. Naumkin, Reshaping and linking of molecules in ion-pair traps. *Chem. Phys. Lett.* 643 (2016) 137-141.

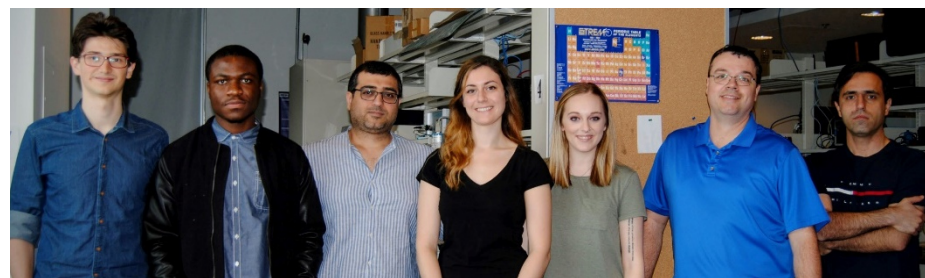
More information: Visit <http://myweb.science.uoit.ca/~fnaumkin> E-mail Fedor.Naumkin@uoit.ca

Dr. Brad Easton

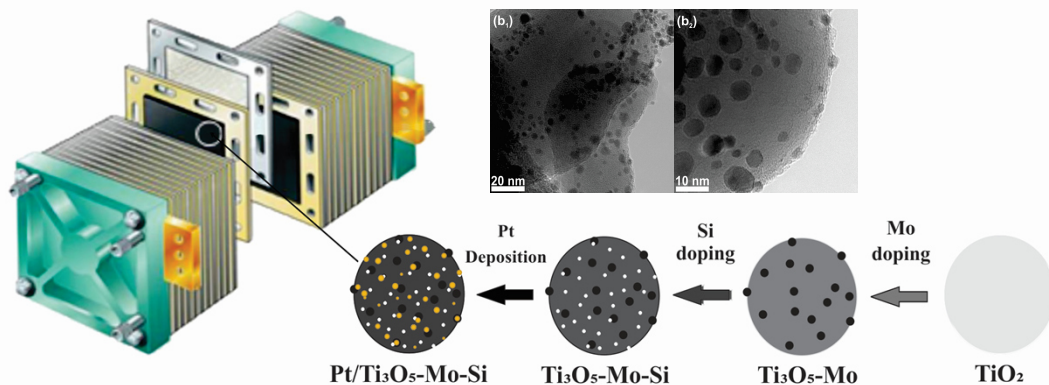
Professor (Chemistry)

UOIT Research Excellence Chair in
Electrochemical Energy Materials

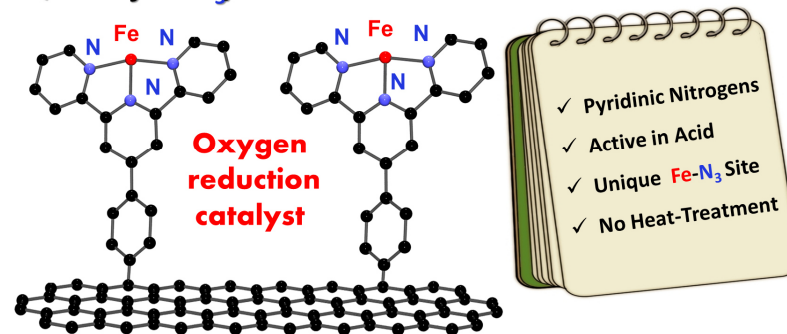
<http://www.bradeaston.ca/>



Research Interests: electrochemistry, materials chemistry, fuel cells, sensors, carbon surface chemistry, H₂ production



Quest of **Fe-N₃/C** Active Site on the Carbon Surface



Selected publications based on undergraduate thesis:

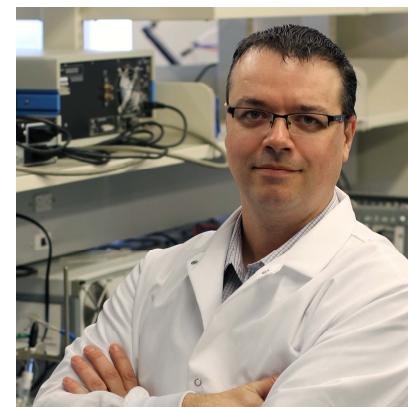
- **J. Poisson, H.L. Geoffrey**, I.I. Ebralidze, N.O. Laschuk, J.T.S. Allan, A. Deckert, E.B. Easton, O.V. Zenkina, *J. Phys. Chem C.*, 122 (2018) 3419 – 3427.
- **K. M. Yarrow**, N. E. De Almeida, E. B. Easton, "The impact of pre-swelling on the stability of Nafion/SS composite membranes", *J. Therm. Anal. Calorim.*, 119 (2015) 807 - 814.
- **O. Reid**, F. S. Saleh, E. B. Easton, "Determining electrochemically active surface area in PEM fuel cell electrodes with electrochemical impedance spectroscopy and its application to catalyst durability", *Electrochimica Acta*, 114 (2013) 278 – 284.

Dr. Brad Easton

Professor (Chemistry)

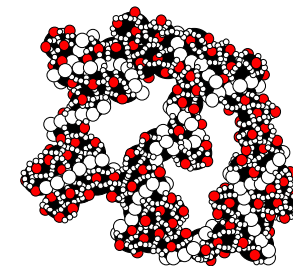
Ph.D. (Memorial University of Newfoundland)

<http://www.bradeaston.ca/>



Available thesis projects for 2019/20

- 1. Electrochemical stability of novel metal oxide-based fuel cell supports*
- 2. Support effects related to photo-enhanced electro-oxidation of organic fuels*
- 3. The preparation of coordination based functional electrochromic materials and metal wires on conductive surfaces.
(co-supervised with Dr. Zenkina)*



Prof. Liliana Trevani

Associate Professor (Chemistry-Materials Chemistry)

PhD in Chemistry – University of Buenos Aires, Argentina

PDF – Memorial University, Newfoundland, Canada

Research Associate – University of Guelph, Ontario, Canada

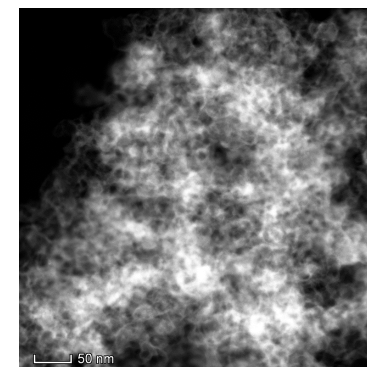
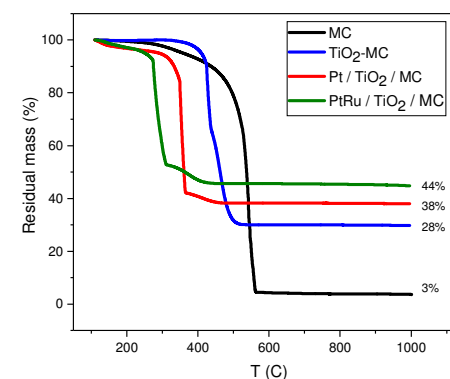
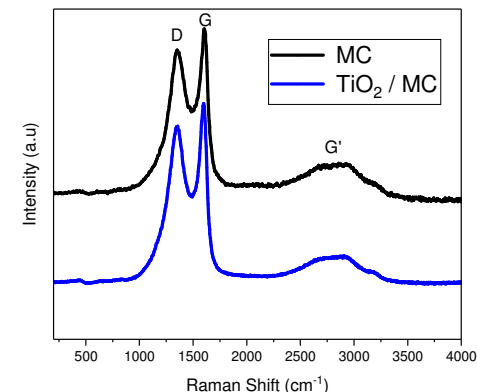
Available thesis projects (2019-2020):

Fabrication of nano-metal structures for plasmonic sensing of pharmaceutical drugs (co-supervised with Prof. Nisha Agarwal, Physics, UOIT)

Development of hybrid carbon nanostructured materials for energy storage and conversion.

Contact: liliana.Trevani@uoit.ca

Website: www.liliana-Trevani.com



Prof. Liliana Trevani

Fabrication of nano-metal structures for plasmonic sensing of pharmaceutical drugs

(Project co-supervised with Prof. Nisha Agarwal, Physics, UOIT)

The project is aimed to investigate the synthesis and characterization of supported metal nanomaterials in silica matrices for surface enhanced Raman scattering (SERS). The application of these nanostructures for the detection of low concentrations of target molecules (including pharmaceutical drugs) will be also investigated. The student will gain experience in several analytical and physical/chemical characterization techniques.

For additional information, see for instance: Jiang et al., Applied Surface Science 378, 181-190 (2016)

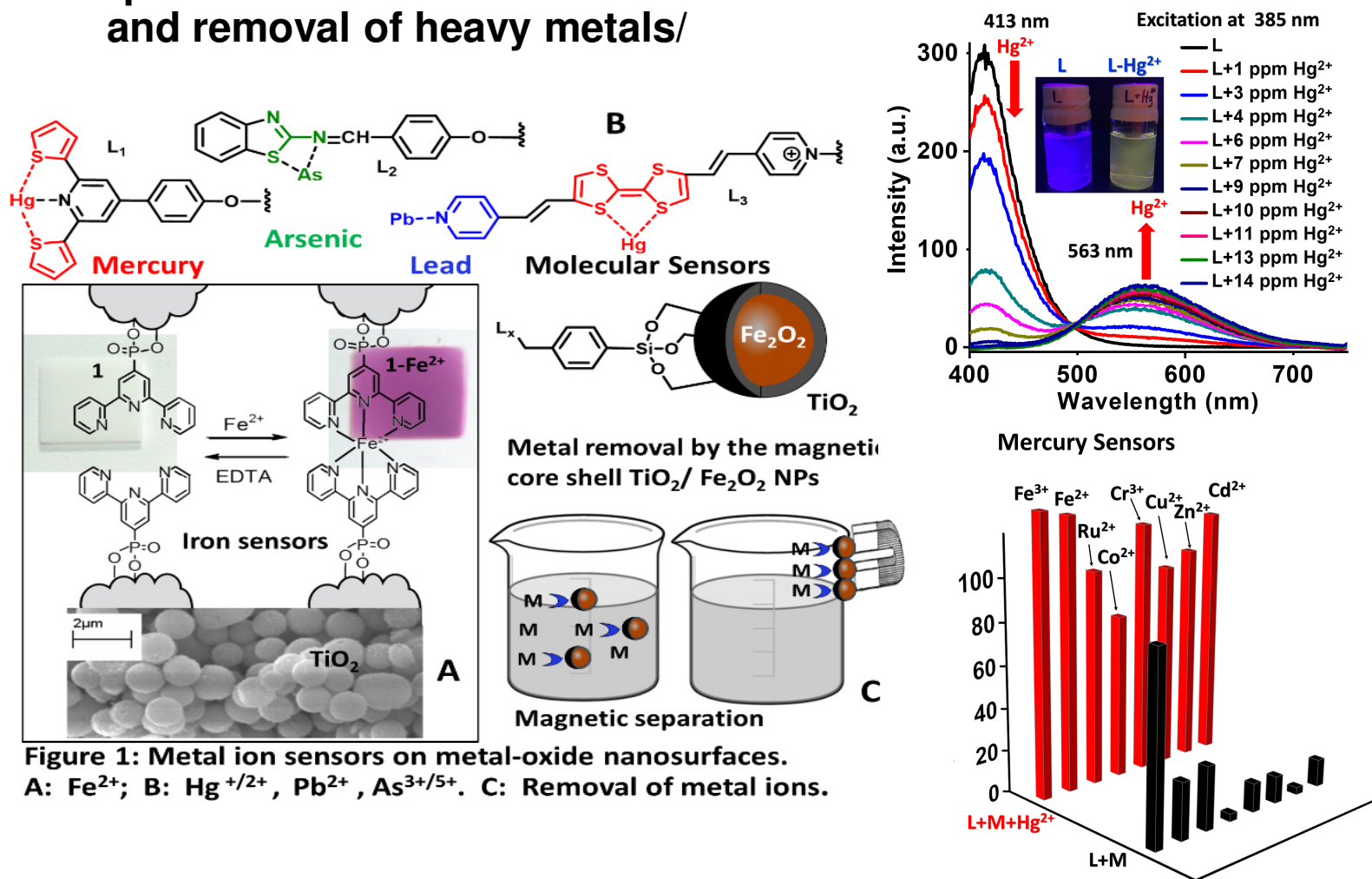
Development of hybrid carbon nanostructured materials for energy storage and conversion.

The thesis project will focus on the synthesis and characterization of novel composite carbon structures for applications in the field of energy storage and conversion. Carbon materials will be produced by carbonization of polymeric materials synthesized in the presence of hard- and soft-templates with the aims of controlling the surface area and pore size distribution of the final products. The deposition and catalytic activity of metal and metal oxide nanoparticles on these materials will be also investigated in collaboration with a graduate student. The student will explore several analytical and physical/chemical techniques used for the characterization of nanomaterials, including electrochemical methods.

For additional information, see for instance: Bruno et al., Colloids and Surfaces A: Physicochemical. Eng. Aspects 362, 28-32 (2010). Forouzandeh et al., J. Electrochemical Society, 165(6), F3230-F3240 (2018)

Prof. Olena Zenkina

1. Preparation of surface confined materials for selective metal ion sensing and removal of heavy metals/



Laschuk N. O., Ebralidze I. I., Quaranta S., Kerr S., Egan J. G., Gillis S., Gaspari F., Latini A., Zenkina O.V., *Materials & Design*, 2016, 107, 18–25.

Laschuk N. O., Ebralidze I. I., Spasyuk D., Zenkina O. V. "Eur. J. Inorg. Chem. 2016, 22, 3530-3535.

Undergraduate student authors marked in red

Prof. Olena Zenkina and Prof. Brad Easton

2. The preparation of coordination based functional electrochromic materials and metal wires on the conductive surfaces.

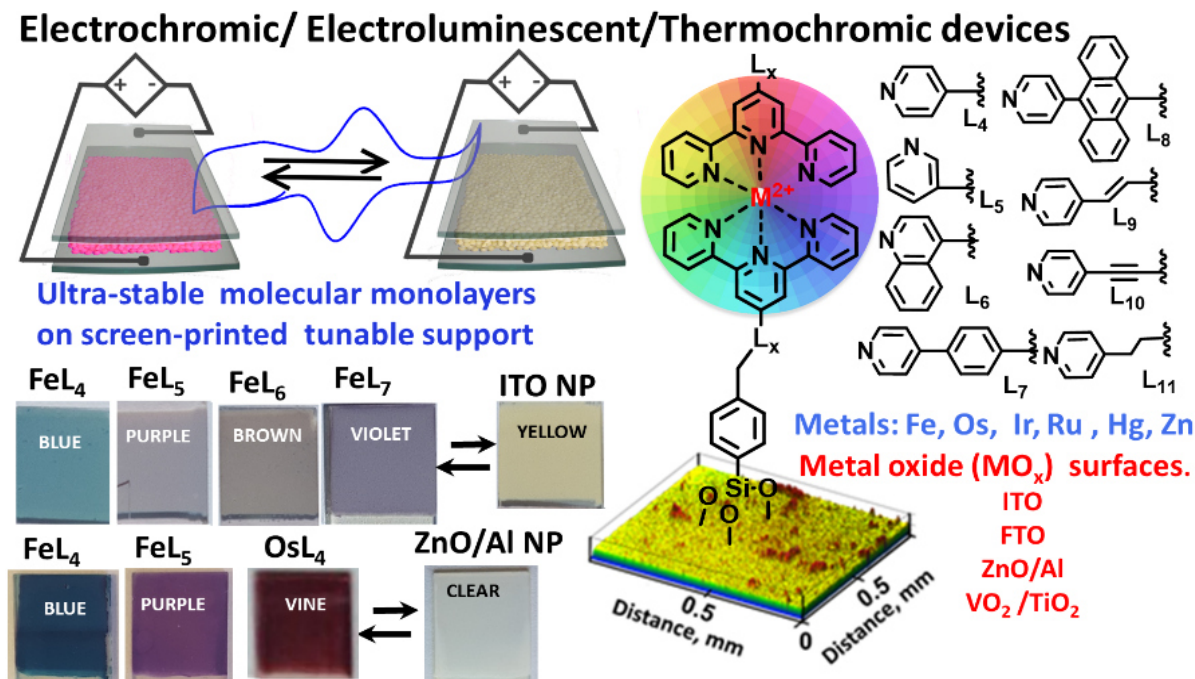


Figure 3. “Smart” chromogenic metal complexes on “intelligent” MO_x surfaces.

Laschuk N.O., Ebralidze I.I., **Poisson J.**, Egan J.G., Quaranta S., **Cusden H.**, Allan J.T.S., Naumkin F., Gaspari F., Easton B., Zenkina O.V. *ACS Applied Materials & Interfaces*. **2018**, 10 (41), 35334–35343

Poisson, J.; **Geoffrey, H. L.**; Ebralidze, I. I.; Laschuk, N. O.; Allan, J. T. S.; **Deckert, A.**; Easton, E. B.; Zenkina, O. V., *J. Phys. Chem. C* **2018**, (122), 3419–3427.

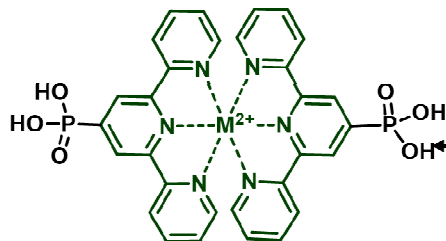
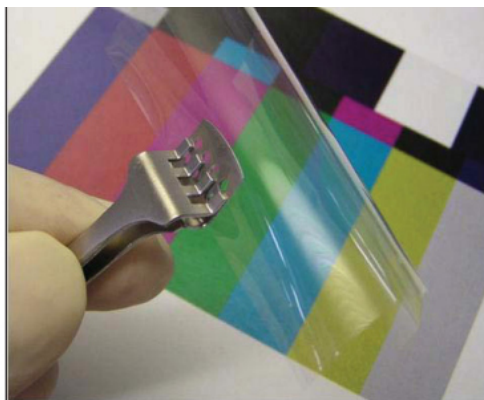
Allan, J. T. S.; Quaranta, S.; Ebralidze, I. I.; **Egan, J. G.**; **Poisson, J.**; Laschuk, N. O.; Gaspari, F.; Easton, E. B.; Zenkina, O. V., *ACS Applied Materials & Interfaces* **2017**, 9 (46), 40438-40445.

Undergraduate student authors marked in red

Prof. Olena Zenkina

3. Nanocellulose based conductive surfaces for smart molecular materials.

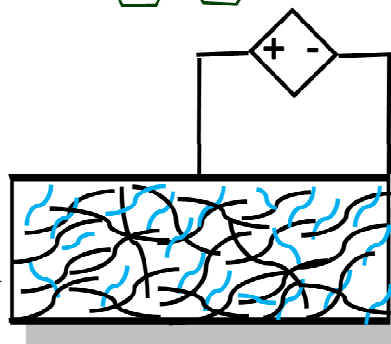
Adv. Funct. Mater. 2014, 24, 1657–1663



Phosphonate linker

Covalent robust attachment,
Water-soluble ink materials

Silver nanowires:
Enhanced conductivity



✓ Transparent, flexible,
conductive, rough, foldable
surfaces



Nanocellulose, or nanofabrics
Biodegradable high surface area
support, cell wall rupturing effect

We interested to make a water-soluble ink of different colours from well-defined transition metal complexes and to be able to “write” (covalently introduce electrochromic molecules) on the transparent biodegradable nanopaper. Novel materials may allow an easy electrochemically switching between colours and/or erasing of colours.

We target erasable, bendable transparent, multicolour electrochromic paper.

This is totally new research direction in our group.

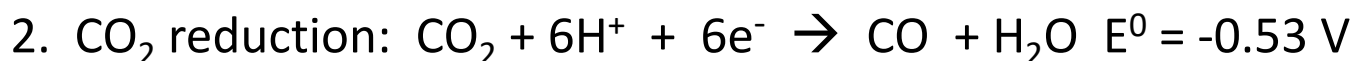
We will closely collaborate with group of Prof. Easton on Electrochemistry side of this project!

Dr. Kevin Coulter

NOTE: Dr. Coulter has **NO PROJECTS AVAILABLE** for 2020-2021
(away on leave Sept 2020 – Feb 2021)

Research Area: Inorganic and Organic Synthesis, Electrocatalysis

Objective: Test both novel and existing Inorganic metal complexes for their activity as catalysts for the key “solar fuels” reactions:



Chemistry Honours Thesis Guidelines

(2019-2020)

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- 2. Introduction**
- 3. Qualification for the Honours Thesis**
- 4. Selection of a Project**
- 5. Evaluation Scheme**
- 6. First Semester Evaluation**
- 7. Formation of the Examining Committee**
- 8. Oral Defence**
- 9. Dissertation**

Important Dates

Dec. 15, 2019	Supervisor must complete and submit CHEM 4410U progress report to UPD, assessing whether or not the student's performance and progress are acceptable enough to continue in the Winter with CHEM 4420U, due the last day of the Final Exam period
Jan. 6, 2020	Classes begin , winter semester
Feb. 14, 2020	Supervisor must inform the student (in writing) of the composition of the examining committee ; typically one external examiner will be assigned
Feb. 26, 2020	Students will be notified of the exact date of the oral defence.
March 2020	recommended but not required: Southern Ontario Undergraduate Student Conference (SOUSCC) 2020 (at Ryerson U), date not confirmed (webpage not available yet, search "SOUSCC 2020" to see when the webpage is up)
Mar 13th 2020	Students must submit a written first draft of the dissertation to supervisor and examiner who may or may not give revisions
Mar 23-27th 2020	Oral Defense. Exact date and location to be determined
Apr 3rd 2020	Students must submit a final draft of their written dissertation for marking due the last day of classes
April 13th 2020	Examining committee returns the written dissertation to the student detailing final corrections.
April 17th 2020	Final revised version of the written dissertation must be submitted by the last day of the Final exam period.

Introduction

This guide describes the policies and procedures governing the honours thesis option for students in chemistry in the Faculty of Science at the University of Ontario Institute of Technology.

The thesis option consists of two courses: CHEM 4410U and CHEM 4420U. Each course constitutes 3 credit hours of the 120 credit hours required for an honours degree. Students are expected to enroll and pass CHEM 4420U immediately following CHEM 4410U. Under most circumstances, these courses will be taken in the fall and winter semesters of the student's final academic year.

The completion of the honours thesis is expected to require at least 230 hours of work on the part of the student (i.e., an average of 9 hours per week in each of the two semesters). The majority of this time will be spent in the laboratory conducting original research under the supervision of a faculty member. The evaluation of the chemistry honours thesis will be based on three components: i) in-lab performance; ii) oral defence of the thesis; iii) written dissertation.

Both the student and the faculty supervisor should familiarize themselves with policies and procedures governing the honours thesis. These guidelines should not be interpreted as superseding any regulations described in the university calendar or general policies of the Faculty of Science.

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To qualify for the honours thesis in chemistry a student must:

1. Have completed 90 credit hours toward their degree by the beginning of the fall semester of the year in which they intend to take CHEM 4410U / 4420U.
2. Have a GPA of 2.0 and be in clear academic standing.
3. Have passed at least four of: CHEM 3040U, CHEM 3120U, CHEM 3220U, CHEM 3520U and CHEM 3540U.

Students who have not completed 90 credit hours at the end of their third-year may be admitted provisionally to CHEM 4410U if they can show that they will have completed 90 credit hours by the start of the fall semester.

Selection of a Project

Each year faculty members in the Faculty of Science willing to supervise undergraduate theses in chemistry will provide a list of thesis projects from which a student may choose. Normally, a student completing a programme in chemistry will do a project under the supervision of one of the chemistry faculty members. However, projects from other disciplines (or even other Faculties) may also be acceptable as long as the research involves significant chemistry content. Such projects require the approval of the Chemistry Undergraduate Studies Committee.

Students may apply to work on a project by completing the “Honours Thesis Application” form available on the Faculty of Science website. The completed form is submitted to the Undergraduate Program Director (UPD) for Chemistry. Acceptance by an individual supervisor is not guaranteed and is at the sole discretion of the supervisor. Students must apply to work on a project by **April 30th** of the year prior to starting the research project.

Evaluation Scheme

Evaluation of the thesis will consist of three parts:

1. “In-lab” performance (40%)
2. Oral defence of the thesis (20%)
3. Written dissertation (40%)

Each part must be completed, otherwise the course is failed.

The “in-lab” performance will be evaluated solely by the student’s faculty supervisor. It will be based on the effort and quality of work the student produces while working in the laboratory.

The oral defence will be a 20 minute public presentation (including questions). The basis for the evaluation of the oral defence is given below.

The written dissertation will be a 30 - 50 page report which includes a literature review and the results and significance of the research. More information on the format of the dissertation is given below.

First Semester Evaluation

At the end of the first semester, supervisors will assess the progress of the student using the CHEM 4410 Thesis Progress report form and submit it to the UPD. The supervisor must give a copy of this report to the student and should meet with the student to review the assessment. If student performance is deemed inadequate, the student will not be permitted to continue in CHEM 4420 (Chemistry Thesis II).

Formation of the Examining Committee

The student’s examining committee will usually consist of two members: the student’s faculty supervisor and one other faculty member (the “assessor”) chosen by the student’s supervisor. The second member will be conversant with the general area of the student’s research and normally be chosen from within the Faculty of Science. For some theses, it may be appropriate to have a committee member from another Faculty. However, at least one member of this committee will be a chemistry faculty member.

The student’s supervisor will inform the student (in writing) of the composition of the examining committee by the date given in the timeline above

Oral Defence

Each student will present a 20 minute, public defence of his / her thesis. This includes time for questions from the audience.

Normally, all the oral defences will be scheduled in the same session. However, because of student schedules or the number of candidates this may not always be possible. The oral defence will normally be scheduled in the last full week in the month of March. Students will be notified of the exact date in the last week of Feb on the date given in the timeline above.

The candidate will submit a draft of the written dissertation to their supervisor and to the assessor at least two weeks prior to the scheduled oral defence. This draft will also be reviewed by the supervisor and assessor in advance of the defence. An abstract (in electronic form) should also be provided to be distributed amongst the general audience attending the seminars.

A grade out of 20 will be assigned for the oral defence based on a combination of the evaluations of the examining committee and of the other faculty members present at the seminar.

Dissertation

After the oral defence, the members of the examining committee may or may not suggest changes to the thesis in advance of the submission of the dissertation for marking. A draft of the written dissertation intended for marking is due on the last day of classes in which the student is enrolled in Chemistry 4420. This draft will be marked by the two members of the examining committee and a final grade for the dissertation will be based on an equal-weighted average of the two grades assigned by the examining committee.

As a result of this marking, certain corrections to the thesis (these should be quite limited) may be required before final submission. The student must complete these revisions and submit a final (electronic) version of the dissertation by the last day of exams for the semester in which the student is enrolled in Chemistry 4420. The electronic version should be in “pdf” format.

A student who fails to submit the final draft of the thesis by the last day of exams will be given an incomplete (“INC”) grade.

General Format of Written Dissertation

The components of the dissertation should be presented in the following order:

1. Title page
2. Assertion of Original Work
3. Abstract
4. Acknowledgments
5. Table of Contents
6. List of Tables
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8. List of Abbreviations and Symbols
9. List of Appendices
10. Main text
11. Bibliography and references
12. Appendices

Not all dissertations will require all these elements.

The dissertation should be prepared using a “serif” font. The preferred font is Times New Roman (the same font used in this document). The main text should be 12 point. Smaller font sizes may be suitable for footnotes, graphs, etc. but the font size must allow the text to remain legible at all times.

The dissertation should be printed on standard 8.5 x 11" white photocopy paper using a laser printer. Initial (unbound) drafts may be printed double-sided. If a copy of the thesis is to be bound, it must be printed single-sided.

Margins should be set with 1.5" on the left (to allow for binding), 1" on the right and at the top and bottom.

Line spacing should be double.

Each page of the dissertation must be given a page number centred at the bottom of the page. Pages preceding the main text should be numbered using lower case Roman numerals. While the title page is considered page (i), a page number does not appear on the title page. Pages in the main text should be numbered sequentially beginning with the first page (i.e., the first page of the main text is page (1)). Arabic numerals must be used for page numbering in the main text.

Each equation in the dissertation should be prepared using the equation editor of the word processing software and be presented on a separate line. Each equation should have a unique number. The “decimal” numbering system is recommended. For example, the third equation appearing in chapter 2 would be numbered as 2.3.

All figures appearing in the dissertation should be presented on a separate page. The caption associated with each figure should be presented below each figure. Each figure should be numbered using the decimal system. All figures appearing in the dissertation must be referred to in the text of the dissertation.

Each table appearing in the dissertation should have a title (above the table) and be numbered using the decimal system. All tables appearing in the dissertation should be referred to in the text.

References in the dissertation may be cited using either numbered end-notes or using alphabetical end-notes.

When using numbered end-notes, the citations should be numbered sequentially and the number should appear in line with the text. For example:

The spectrum of the carbonyl region is identical to that of pure methyl formate [28].

The reference would then be given as:

28. Z. Deng, D. E. Irish, *Can. J. Chem.*, **1991**, 69, 1766

When using alphabetical end-notes, the citation should be given using the surname of the first author and the year of publication. For example:

Tomlinson, Curnutte and Hathaway were specific in concluding the liquid consists of helical polymers (Tomlinson, 1970).

The reference would then be given as:

Tomlinson, G. E., Curnutte, B., Hathaway, C. E., *J. Molec. Spec.*, **1970**, 36, 26.

All references would be listed alphabetically in the bibliography.

Title Page

The title page should include the title of the thesis, the name of the author and the semester in which the dissertation has been submitted. An assertion of copyright should be included.

The title of the thesis should be sufficient that the nature of work is easily recognizable. It should also contain electronically searchable key-words.

An example title page is given and the end of these guidelines.

Assertion of Original Work

This is a statement by the student that the dissertation presented is solely the work of the student. An example statement is given below.

Abstract

The abstract should be no more than 250 words long and should contain sufficient information to allow an assessment of the relevance and interest to a potential reader. It should contain the objective of the research and, very briefly, the conclusions.

Acknowledgements

The assistance, advice, encouragement and monetary support (e.g., granting agencies) of others should be stated. If prior work or research data has been included as part of the dissertation, it is appropriate to acknowledge this in this section.

Table of Contents

A “decimal” system is recommended. Each heading and sub-heading appearing in the Table of Contents must also appear in the main text of the dissertation.

An example of a partial Table of Contents is given below.

Lists of Tables, Figures, etc.

The lists of tables, figures, abbreviations, etc. must follow the table of contents. Each list should appear on a new page with an appropriate page number.

A decimal system is recommended for numbering tables and figures. For example, Figure 3.2 would be the second figure appearing in chapter 3. All figures and tables appearing in the dissertation should be numbered and included in the lists.

Main Text

The format of the main text of thesis will be governed, to some degree, by the nature of the work and the results from the experiments. However, in very general terms, the main text should contain the following elements:

1. Introduction

The introduction should include a clear statement of the objective of the research and why the research is important or interesting to the wider field of chemistry. The introduction usually includes a brief review of the literature relevant to the research project to establish context of the problem and to explain the current knowledge in the field. Any relevant theory should be described.

2. Experimental

The experimental section explains the experimental or computational methods, conditions and details of the data collection or generation. Relevant instrumentation should be described here. Any data reduction or analysis (e.g. curve fitting, deconvolution, regression analyses) used to transform the original data to final results should be described.

3. Results and Discussion

The results of the experiments should be presented in this section of the thesis. This can often be done most efficiently using tables and figures of data. The significance or importance of the results should be discussed and explained with reference to the objective of the project. How (and why) the results support or refute the hypothesis of the research should be discussed. The relevance of the results should be discussed in the context of the current literature.

4. Conclusions and Future Work

This should be a fairly brief section that summarizes the findings of the research. Whether or not the objective of the research was met should be discussed. Suggestions for future work to resolve new questions raised by the research should be made.

Bibliography and References

This section of the thesis should include proper citations of all the relevant literature (books, journal articles, monographs, etc.) used in the dissertation.

The format to follow for citing journals is:

Author names, *journal title*, **year**, volume, page number

Z. Deng, D. E. Irish, *Can. J. Chem.*, **1991**, 69, 1766

Books should be cited as:

Author names, *title*, publisher, location, date

W. A. Guillory, *Introduction to Molecular Structure and Spectroscopy*, Allyn and Bacon, New York, 1977

Monographs should be cited as:

Author names, *title*, chapter, (editors), publisher, location, date

B. J. Bulkin in *Analytical Raman Spectroscopy*, Chap. 1 (J. G. Grasselli and B. J. Bulkin Eds.), John Wiley and Sons Inc., Toronto, 1991.

Appendices

Appendices are used to report information (e.g. raw data, computer code, data needed for data analysis but not collected as part of the thesis) that, if included in the main text of the thesis would detract from the readability of thesis.

MEASUREMENT OF THE EQUILIBRIUM CONSTANT FOR ION PAIRING BETWEEN
 Zn^{2+} AND NO_3^- IONS IN AQUEOUS SOLUTIONS USING RAMAN SPECTROSCOPY

By

D. E. Brooker

A thesis presented to the University of Ontario Institute of Technology
in partial fulfilment of requirements
for the degree of Bachelor of Science (Hons)
in Chemistry

Oshawa, Ontario, Canada
Winter, 2014

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Assertion of Original Work

I declare that this dissertation is solely my own, original work.

Unless stated otherwise in the dissertation, the experimental results presented in the dissertation are the results of my own work.

<include student name and student number>

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