

Bruce M. Mattson, Ph.D.

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Education:

- 1979 - 1980: University of Alberta, Edmonton, Alberta Canada: Post-doctoral appointment. Research in synthetic organometallic chemistry. Research Director: Dr. W. A. G. Graham
 - 1973 - 1977: University of Minnesota, Minneapolis, Minnesota: Ph.D. in Inorganic Chemistry, 1977. Research in synthetic inorganic coordination chemistry. Thesis Title: *The Oxidation, Reduction, and Photochemistry of Ruthenium Dithiocarbamate Complexes*; Research Adviser: Dr. L. H. Pignolet
 - 1969 - 1973: Southwest State University, Marshall, Minnesota: B. A. in Chemistry, 1973.
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Work Experience:

- Creighton University, Omaha, Nebraska:
 - 1994 - Present: Professor of Chemistry
 - 1985 - 1994: Associate Professor of Chemistry
 - 1980 - 1985 and 1977 - 1979: Assistant Professor of Chemistry
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Honors and Awards:

- May, 2015, 8th International Symposium on Microscale Chemistry, 27 – 29 May 2015, Universidad Iberoamericana, Mexico City. Special recognition given for my “extensive merits in the field of microscale gas chemistry.”
- April, 2012, Faculty Recognition Award by Student Support Services.
- 2013 I am the recipient of an “IGGY Award,” affectionately named after Jesuit founder St. Ignatius, the IGGY Award is sponsored by Academic Success within the new EDGE program and is awarded to outstanding freshman mentors, counselors, advocates and role models as part of our Founder’s Week celebration.
- 2004 25-Year Service Award, Creighton University
- 2001 Omricon Kappa Delta
- 1998 Recipient Deans Award for Excellence in Teaching
- 1998 Co-recipient of the William F. Kelley, S.J. Achievement Award, Outstanding Service Achievement for our department's field day activities.
- 1997 Co-recipient of the William F. Kelley, S.J. Achievement Award, Outstanding Service Achievement for our “Melodious Musichemical Manifestation” program

- Western Connecticut Section of the American Chemical Society, Visiting Scientist Award, 1995.
- Outstanding Alumni Achievement Award, 1993, Southwest State University, Marshall, MN.

Administration:

- Chair, Department of Chemistry, Creighton University, 1993 – 1999 and Acting chair, May – December, 2005. Our department had fourteen faculty members, three staff members and a sizeable budget.

Research Interests

My recent long-term interests are with gas phase reactions taking place over an alumina-supported nanoparticle palladium catalyst developed in our laboratory. Among the interesting reactions being studied by high-field nuclear magnetic resonance and mass spectroscopy are:

- ❖ Deuteration of alkynes and crossover experiments to elucidate D/H exchange
- ❖ Deuterium exchange in methane producing five isotopomers, $\text{CH}_{4-n}\text{D}_n$, $n = 0 - 4$.
- ❖ Hydrogen absorption onto/into palladium metal, a process that we have studied by kinetics for presentation as a classroom demonstration. We have written one article on this topic and it has appeared in the ***Journal of Chemical Education***.
- ❖ Dihydrogen (H_2) and dideuterium (D_2) undergo D/H statistical exchange in the presence of the catalyst at temperatures as low as $-78\text{ }^\circ\text{C}$.
- ❖ We have established an understanding of the mechanism for the deuteration of 1-butene. The reaction was followed by mass spectroscopy and proton-nmr. In this work, we have learned that deuterium/hydrogen exchange is faster than deuteration across the double bond, so that the deuterobutanes produced have between 1 and 5 deuterium atoms.

Ongoing work related to microscale gas chemistry involves maintaining our website. The purpose is to provide methods for generating and manipulating small quantities of gases safely in 60 mL syringes. Prior to our work, it was unfeasible to generate several of these gases in the classroom or student laboratory. All together over 150 experiments have been devised for 18 gases including CO_2 , H_2 , O_2 , N_2 , NH_3 , NO_x , C_2H_2 , H_2S , SO_2 , Cl_2 , HCl , CO , C_2H_4 , SiH_4 , CH_4 , N_2O , and O_3 , all described at our gas chemistry web site (redesigned in 2016 and updated most recently in November 2016):

http://mattson@creighton.edu/Microscale_Gas_Chemistry.html

Research Supervision

Directed research with Reba Mehaffey, Summer 2017 - Present
 Directed research with Kenzie Enmeier, Summer 2017 - Present
 Directed research with Tazah Weinmaster, Spring 2017 - Present
 Directed research with Samantha Jarman, Fall 2015 – Spring 2017.
 Directed research with Anne Mirich, a Clare Boothe Luce scholar, Spring 2015.
 Directed undergraduate research for several dozen Creighton University undergraduate students, many of whom were coauthors on publications listed below.

Pedagogical

- **Courses taught** (within the past 5 years)
 - Chm 203 and 205, General Chemistry I and II, every year.
 - Chm 204 and 206, General Chemistry Laboratory I and II
 - RSP 101, Ratio Studiorum, Fall 2015
 - Chm 451, Inorganic Chemistry
 - Chm 502, Inorganic Chemistry II
- **Author/Co-author:**
 - ***Microscale Gas Chemistry, 4th Edition***, Mattson, B. M., Anderson, M. P.; and Mattson, S. E.; published by Educational Innovations, 2006. This book is now sold by Flinn Scientific (new in the 2008 Flinn catalog). The book is now available as a free download from my website.
 - ***Classroom Demonstration Aids That You Can Build!***, Mattson, B. M., Kubovy, M. A., Hepburn, J., Lannan, J., published by Flinn Scientific, 1997.
- **New Course Development:**
 - Spring, 2015, Developed a new experiment based on using visible spectroscopy to identify metal ions in mixtures for Chm 206 (as a make-up lab)
 - Microscale Gas Chemistry, Chm 555
 - Organometallic Chemistry, Chm 502
 - Advanced Inorganic Chemistry Laboratory, Chm 351

College and University Committees and Service to the Chemistry Department (past ten years):

- College letter write to admitted students, and host for classroom visits for students and families.
- Successfully nominated five students to Alpha Sigma Nu in 2016.
- Baumann Family Scholarship, administrator, 1987 – present.
- Ambassador for Chemistry Department at Opus Prize Interfaith Service, November 16, 2016.
- Reviewer, 2016 Summer Undergraduate Research Fellowship applications, February, 2016.
- Eric Villa faculty mentor, Fall 2013 – Present. In this capacity, we meet once a week to discuss a variety of issues, with the bulk of the discussion pertaining to teaching of General Chemistry
- College's Mission Implementation Committee "Catalyst Committee", 2011 – 2012, 2014 - Present
- Coordinated the Creighton Chemistry Community Development Fund project and wrote the "rules" for the administration of the fund, Fall, 2015.
- Governance Committee, Department of Chemistry 2007 - Present

- Magis Core University committee member, 2013 - 2015
- Inorganic faculty search committee member, 2015
- Club Soccer, Faculty Moderator, 2013 - 2015
- General Chemistry Committee (occasional)
- Inorganic Division leader (past)
- Calling All Jays, October 7, 2015
- Biochemistry faculty search committee member, 2013 and 2014
- Analytical Professor Search Committee, Fall 2012
- Faculty Senate of Creighton College of Arts and Sciences (2005 – 2011)
- Professional Development Committee, Fall Semester, 2008 – 2011
- Curriculum Committee, Fall Semester, 2007 – Spring 2008
- Chemistry Department webmaster, 2001 - 2012
- Chemistry Department Strategic Planning Committee, now inactive
- Review team, Department of Sociology, March 14 – 16, 2006
- College Rank & Tenure Committee, two terms, ending Spring 2006.
- Cardoner Project Investigating/Discussing Scholarship as a Calling, 2004 – 2005
- Participant in Collaborative Learning Work Group, 2010 and 2011.
- Research Advisory Cmte for Academic Affairs, 2007 – 2009 (Reviewed Research Initiative Grant Proposals, Spring Semesters of 2008, 2009)
- Chair mentor, Department of Modern Languages and Literatures, Fall, 2006 – Spring 2009.

Service to the Profession and Private Consulting (past ten years):

- Frequent reviewer for Journal Chemical Education, averaging two reviews per year (two in 2016)
 - Reviewer, Review of Manuscript Number POLY-D-15-00671, August 2015
 - External evaluator for a faculty member applying to promotion to professor at another Midwestern university, July, 2013.
 - External reviewer, Department of Chemistry St. Mary's College, Notre Dame, IN, site visit will take place in February, 2010 (some preliminary work was done in 2009)
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List of Professional Presentations 2014 - Present

- April 21, 2017: On the hydrogenation of alkynes with alumina supported palladium, Samantha Jarman and Bruce Mattson, (presenter: Samantha Jarman) Nebraska Academy of Sciences, Lincoln, Nebraska
- April 1, 2014: On the deuteration of methane over palladium, Anne Mirich, Bruce Mattson, St. Albert's Day. (presenter: Anne Mirich)
- April 11, 2014: On the deuteration of methane over palladium, Anne Mirich, Bruce Mattson, (presenter: Anne Mirich) Nebraska Academy of Sciences, Lincoln, Nebraska
- April 23, 2014: Baumann Family Scholarship report, by Anne Mirich, Chemistry Department.
- May 27, 2015: (Keynote address) On the Gas Phase Deuteration of 1-Butene and Methane, 8th International Symposium on Microscale Chemistry, Iberoamericana Universidad, Mexico City.
- May 27 and 28, 2015: Microscale Gas Chemistry Workshop, Iberoamericana Universidad, Mexico City.

Sabbatical Report, 2016

Abstract of approved sabbatical project:

Ethyne readily chemisorbs to palladium metal. If hydrogen or deuterium is present, a variety of reactions are theoretically possible. These include (1) hydrogen/deuterium exchange, (2) hydrogenation/deuteration of ethyne to produce all isotopologues and isotopomers of polydeuterated ethene and ethane, (3) oligomerization to form larger hydrocarbons, and all combinations thereof. I intend to study this reaction with our Creighton-designed catalyst tube. When not in the lab, I will work on revamping and updating my Microscale gas Chemistry website.

Part 1. The Alkyne hydrogenation project. During my sabbatical, I continued to work with my research student, Samantha Jarman, a senior chemistry major. We were able to learn quite a bit about the interaction between alkynes and our nanoparticle palladium catalyst tube. In addition to ethyne, we studied 1-butyne. Each contributed to a much better understanding of the interactions between alkynes and our catalyst. Of the three open questions listed in the abstract, we can definitely say the first and third ones do not happen at room temperature, and probably does at elevated temperatures via a different mechanism. Alkynes become hydrogenated/deuterated forming alkenes, and they in turn can be hydrogenated/deuterated further to form alkanes without undergoing D/H exchange. Our catalyst, in fact, behaves much like the majority of versions of supported palladium catalysts. Regarding Question 2, we found that alkynes interact strongly with the palladium nanoparticle, undergoing chemisorption with the donation of four π -electrons to the surface. From there, hydrogenation proceeds via a σ -vinyl intermediate yielding Z-addition of the hydrogen or deuterium. The resulting Z-alkene, already in proximity (already π -bonded to Pd), can undergo hydrogenation with extensive D/H exchange via the Horiuti-Polanyi mechanism, of which we have published in the past. Approximately six interesting questions were raised and answered during the course of the

investigation. The results are being presented at the Nebraska Academy of Sciences in April by Samantha. We have continued to explore this reaction this semester.

The other component of my sabbatical was to “produce an updated version of the Microscale Gas Chemistry website.” This took an enormous amount of time due to the fact that I was not limited to black-and-white figures that the paper copy of the text required. I was able to add color photography of the reactions to every chapter and You-Tube videos in several places as well. The book can be explored and downloaded (by chapter) at [http://mattson.creighton.edu/Microscale Gas Chemistry.html](http://mattson.creighton.edu/Microscale_Gas_Chemistry.html). Over 77,000 people have visited the site.

Part B of Instructions. Submit additional evidence of pedagogical development or achievement from the calendar year 2016

We have published 17 articles in the past 10 years and 56 articles in the past 20 years and with just a few exceptions, they all deal with chemistry pedagogy. My undergraduate research students address interesting aspects of microscale gas chemistry and, more recently, how a nanoparticle palladium catalyst can be used to facilitate reactions. Most of these articles describe methods that could be used in classrooms, teaching laboratories and undergraduate research laboratories. Our most recent work with the catalyst tubes provides many opportunities for further development and *inquiry-based learning*. For example, the results of most experiments suggests further experiments. I have used many of the concepts worked out by my students in my classroom to demonstrate concepts under discussion. For example, just within the last week, I used the mini-catalyst tube to show how automobile catalytic converters worked: I converted a mixture of hydrocarbon gas and red-brown nitrogen dioxide to produce colorless carbon dioxide, water vapor and nitrogen gas.

List of Publications for Bruce Mattson (last 10 years)

88. Function and importance of nanoparticles in catalysis Part 3, Bruce Mattson* and Samantha Jarman, **Chem13 News**, 2018, (~April 2018)
87. Function and importance of nanoparticles in catalysis Part 2, Bruce Mattson* and Samantha Jarman, **Chem13 News**, 2018, (~March, 2018)
86. Function and importance of nanoparticles in catalysis, Bruce Mattson* and Samantha Jarman, **Chem13 News**, 2017, 435, 12-15. This is a 3-part series on Bringing New Chemistry into the Classroom: Nanoparticles and Catalysis Series.
85. Heterogeneous catalysis: deuterium exchange reactions of hydrogen and methane, Anne Mirich, Trisha Hoette Miller, Elsbeth Klotz, Bruce Mattson*, **Journal of Chemical Education**, 2015, 92, 2087–2093.
84. Structural characterization of dissolved organic matter: a review of current techniques, Elizabeth C. Minor, Michael Swenson, Bruce Mattson, and Alan Oyler Environmental Science: Processes and impacts, *The Royal Society of Chemistry*, 2014, 16, 2064-2079.
83. Heterogeneous catalysis: The Horiuti-Polanyi mechanism and alkene hydrogenation. Bruce Mattson*, Wendy Foster, Jaclyn Greimann, Trisha Hoette, Nhu Le, Anne Mirich, Shanna Wankum, Ann Cabri, Claire Reichenbacher, and Erika Schwanke, **Journal of Chemical Education**, 2013, 90 (5), 613–619.
82. The Spark(l)ing Vinaigrette,” Jorge Ibanez, Jorge Vazquez-Olavarrieta, Max Moran-Orozco, Elizabeth Garcia-Pintor, Angela Köhler-Krützfeldt, Michael Anderson, Bruce Mattson; **Journal of Chemical Education**, 2011, 88, 1404 – 1405.
81. The Equilibrium Constant for Bromothymol Blue: A general chemistry laboratory experiment using spectroscopy, Elsbeth Klotz, Robert Doyle, Erin Gross* and Bruce Mattson**, **Journal of Chemical Education**, 2011, 88, 637 – 639.
80. “Microscale Gas Chemistry,” Bruce Mattson and Michael Anderson, invited paper to the Association for Science Education (UK)’s premier journal **School Science Review**, 2011, 92, 43 – 48. 79. The remarkable chemistry of potassium dioxide(1-) (potassium superoxide). Two Microscale Classroom Demonstrations.” Andrew Allen, Michael Anderson, and Bruce Mattson; **Journal of Chemical Education** 2009, 86, 1286 – 1289.
78. Hydrogen and palladium foil. Two classroom demonstrations. Klotz, E.; and Mattson, B. **Journal of Chemical Education** 2009, 86, 465 – 469.
77. Microscale Gas Chemistry, invited commemorative article, Mattson, B., **Chem13 News** 2008, 361, 15 - 18.

76. "Microscale Gas Chemistry, Part 29. The Mini-Ozone Generator and Bacteria in Natural Aquatic Samples," Bruce Mattson, Stephanie Gallegos, Laleh Mehrrafiee, Jiro Fujita, **Chem13 News 2007**, 351, 8 – 10.
75. "Incomplete Combustion of Hydrogen: Trapping the Hydroxyl Radical," Mattson, B.; Hoette, T.; **Journal of Chemical Education 2007**, **84**, 1668 – 1670.
74. "Demonstrating the Paramagnetism of Liquid Oxygen with a Neodymium Magnet," Mattson, B.; **Journal of Chemical Education 2007**, **84**, 1296 - 1298.
73. "Microscale Gas Chemistry, Part 28. Mini-Ozone generator: 800 nanomole/minute," Bruce Mattson, Janel Michels, Stephanie Gallegos, Jorge G. Ibanez, Alejandro Alatorre-Ordaz, Rodrigo Mayen-Mondragon, M. T. Moran-Moran, **Chem13 News 2007**, **344**, 6 – 11.