Thomas G. Richmond - CURRICULUM VITAE - 2022
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Professional Experience:

Professor of Chemistry, University of Utah, 2013 – present
Associate Professor of Chemistry, University of Utah, 1991 – 2012
Interim Dean, University of Utah Honors College, 2011 – 2012
Associate Dean, University of Utah Honors College, 2006 – 2011
Assistant Professor of Chemistry, University of Utah, 1985-1991

Myron A. Bantrell Research Fellow in Chemistry, California Institute of Technology, Pasadena, California, 1983-1985

Education:

Ph. D., M. S. in Chemistry, Northwestern University, Evanston, Illinois, 1979-1983
Sc. B. in Chemistry, Brown University, Providence, Rhode Island, 1975-1979
Amherst Public Schools, Amherst, New York, 1962-1975

Honors and Awards:

College of Science Distinguished Serice Award, 2022
Presidential Succession, Academic Senate, 2017 - 2019
Faraday Lecturer, 2013 - present
Professor Recognition for Excellence in Teaching & Mentoring
(Mortar Board/Ω)
Special Service to Honors Award (Honors College, 2012)
WW Epstein Outstanding Educator Award (University of Utah Chemistry), 2011
Philip and Miriam Perlman Award
for Excellence in Student Counseling, 2005
John R. Park Teaching Fellowship (University of Utah), 2002
Robert W. Parry Teaching Award in Chemistry
(Endowed by the Brady Foundation), 2001
ACS Nobel Laureate Signature Award for Graduate Education, 1998
University of Utah Presidential Teaching Scholar Award, 1997
ASUU Student's Choice Award for Teaching, 1994-1995
Alfred P. Sloan Research Fellowship, 1991-1995
ASUU Student's Choice Award for Teaching, 1992-1993
NSF Presidential Young Investigator, 1989-1994
Undergraduate SAC Teaching Award, Department of Chemistry, University of Utah, 1988
Camille and Henry Dreyfus Foundation Distinguished New Faculty Grantee, 1985

NSF Predoctoral Fellowship, 1980-1983.
Northwestern University Fellowship, 1979-1980.
Senior Chemistry Award, Brown University, 1979.
Departmental Honors and *magna cum laude*, Brown University, 1979.

Research Interests:

Inorganic and organometallic chemistry; Activation of carbon-fluorine bonds; Organometallic chemistry of fluorine; Ligand design and coordination chemistry; Transition metal-based reagents for molecular recognition; Chemical Education; New Chemistry of electron deficient aromatic compounds.

Current Research Co-Workers

Lauren K. Montgomery, Honors Student, June 2022 – present
Senior Honors Thesis: "Charge Transfer and Molecular complexes of pentacyanotrifluoromethylbenzene," Expected Graduation Date, May 2023
Poster Presented, December 2022.

Seodam Kwak, BS, 2020, Research Assistant, September 2022-present
"Synthesis and Characterization of New Charge Transfer Complexes based on 1, 4-*bis*(trifluoromethyl)tetracyanobenzene,"
Poster Presented, December 2022.

Kevin Lutz, Honors Student, December 2022 - present
Senior Honors Thesis: "Molecular Charge Transfer Complexes involving Platinum Coordination Complexes and Electron Deficient Aromatics."
Expected Graduation Date, May 2023.

Brian Kwak, Senior Chemistry Major, December 2022 – present. "Making Liquid Nitrogen Available to Local High School Teachers,"
Expected Graduation Date, May 2023.

Summary of Key Academic and Administrative Contributions at the University of Utah

Associate Dean, Honors College, 2006 – 2012

As Associate Dean of the Honors College, I contributed to all aspects of the operation of the College and was the "face" of the college to students at the University from recruitment to completion of the Honors Degree. This period was characterized by aggressive, yet thoughtful, growth as the Honors Program itself graduated from Program to College status at the University. I participated in the hiring of all key staff members of the College including the Director of Development, Honors Student Recruitment Staff, Scholarship and Academic advisors and the Academic Program Specialist. Another important change that was implemented was the ability of the College to hire faculty independent of traditional departmental bounds and thus provide an increase in job security for outstanding adjunct honors faculty members in the lecturer ranks. Nowhere is this more evident than in the newly opened Donna Garff Marriott Honors Residential Scholars Community (Dedicated, 2012, Total Cost, $30 Million) that is the premier living and learning community on campus and now home to 300+ honors students. I was a full participant in the planning and construction of this building that is now the locus of the Honors College and also serves as a model for future residence halls on campus.

Faculty Advisor and Chair of the Undergraduate Education Committee, Department of Chemistry, 1996 – 2011; Honors Faculty Advisor, 1996 - present

In the late 1990's, the decision of the State Board of Regents to change the Academic Calendar from the Quarter System to the Semester System was one factor that propelled me into the world of academic advising. Although I had always been interested in educational issues and practices outside the traditional bounds of the chemistry department, the scope of this change prepared me for my time in the Honors College and caused me to spend time on other broader educational endeavors. My success in this area was noted as I was the recipient of the Philip and Miriam Perlman Award for Excellence in Student Counseling in 2005 from the University of Utah Alumni Association.

Additional Teaching Activities

As an inorganic chemist, my normal teaching responsibilities have included teaching General Chemistry, Advanced Inorganic Chemistry Laboratory and graduate courses in Reaction Mechanisms and Organometallic Chemistry. I developed a chemistry course with a focus on energy and the environment for non-science students in the Honors College as well as the Think Tank course on (Nuclear) Radiation and Society mentioned above. I am currently developing an Honors General Chemistry I course that has been a missing piece of our curriculum and will provide a small class environment for science students at the start of their career. The manageable size of this cohort will also make it possible to do more project based labs utilizing some of the new instruments described below that are now housed in the Thatcher Building. My excellence in the classroom has been recognized with a number of teaching awards (including several selected solely by students) as well as designation as a Presidential Teaching Scholar by the President of the University.

In the hopes of improving student success in the challenging General Chemistry and Organic Chemistry series that are required by many science, engineering and pre-professional students, I created new Introduction to the Periodic Table (CHEM 1208) and Preparation for Organic Chemistry (CHEM 2308) courses that have served more than 3600 students to date resulting in about $1 million additional tuition & fees to the University. These fully online courses are taken by students prior to enrolling in the General or Organic Chemistry sequences. These gateway courses are often the first demanding science courses that students encounter in college. Preliminary studies suggest these courses are effective in improving student outcomes in both General and Organic Chemistry. They have also provided a significant increase in credit hours taught by the department which has positive financial implications in a budget model predicated on growth in SCH.

Other Administrative Contributions

I have served in the leadership of the Academic Senate (2017-2019) including elected president in 2018. Although much of my time has been devoted to undergraduate education, I have also made significant contributions at the graduate level. In particular, I served as chair of the College of Science Master of Science for Secondary School Teachers of Mathematics & Science (MSSST) Program from 2000-2006 and again from 2012-2017. This program is designed to improve the content knowledge of practicing teachers as they earn an MS (Teaching) degree from the College of Science. In part due to the availability of state funds to support teachers, the program underwent a significant expansion during this period allowing approximately 58 practicing secondary school science teachers, and another 72 in mathematics to earn an MS degree in the past five years. Nearly one-third of them choose chemistry as the focus of their studies.

This additional training is especially important in chemistry since relatively few chemistry teachers in the state actually hold BS degrees in chemistry. It is easy to spot a student in a General Chemistry course that benefitted from a rigorous exposure to chemistry in high school from a knowledgeable and demanding teacher. Success in this program required individual planning for each MS candidate to enable them to profit from courses that were available on campus and fit into the time constraints of a full-time secondary school teacher. Students completed the degree with a project that was normally designed to enhance their teaching in their particular subject although a few choose a more research based project. I remain involved in the program as it has matured to a cohort based model that allows for the funding of dedicated classes for the MSSST students. Along with Dr. Carolyn Kelley, I created an Inorganic Chemistry for Teachers course for a cohort of Chemistry and Biology teachers that completed their degrees in 2012. I taught an updated version of this course in Fall 2017 to a cohort of physics teachers. An exciting aspect of the cohort model is it included an authentic research experience for each teacher in a laboratory on campus. This includes one who spent a summer in my lab and discovered a new catalyst for C-F bond activation chemistry in saturated perfluorocarbons.

The MSSST program is now housed in the Center for Science and Math Education (CSME) and I am an active participant in that group. I was fortunate to be on the search committee that recruited an outstanding and dynamic leader, Dr. Nalani Nadkarni, for the Center for Science & Math Education. I have also served on search committees for other key people that impact students such as the new Director of Orientation for the University and currently the Senior Vice President for Health Sciences.

I have enjoyed the opportunity to serve the University Community in a number of other roles. This includes serving as a Board Member for the Tanner Lectures on Human Values housed in the Tanner Humanities Center. I have served several terms on the Undergraduate Council which addresses University Wide issues in Undergraduate Education. My work with this group has focused on the student experience including working to improve the transfer student experience and strengthen academic advising on campus.

I have served as Chair of the Quantitative Intensive (QI) requirement committee for the past eight years. This group approves courses campus wide that meet the upper division requirement for Quantitative Literacy courses – two of which are mandatory for the BS degree. I have also participated in discussions and pilot projects designed to assess the effectiveness of general education courses for the purpose of accreditation and address the more fundamental question of what it means to be an educated person. I have continued to serve as co-chair of the General Education Curriculum Council.

When I served as Chair of the University Teaching Committee, I lead the structural reorganization of University-wide teaching Awards to its present system that includes several Early Career Teaching Awards to recognize, as the name implies, the contributions to teaching by faculty at a relatively early stage of their careers. It is gratifying to note that the quality of the nominations for this award has remained strong over the years with recipients from all corners of the campus including the chemistry department.

Scholarship and Research

Research in my group focuses on the organometallic chemistry of fluorocarbons. We have used inorganic and organometallic complexes to promote reaction chemistry that can result in activation of the strongest single bond to carbon. Although prized for their chemical inertness, we have discovered examples of metal promoted C-F activation in both aromatic and aliphatic perfluorocarbons at both early and late transition metals. Our early work employed a ligand based approach to provide the first well-defined example of oxidative addition of a C-F bond at the tungsten(0) metal center [22, 26, 36]. Hard-soft acid-base considerations aside, fluoride has proved to be a respectable ligand in organometallic chemistry [32, 42, 52, 54]. This reaction also generated a useful ligand platform for further developments in coordination chemistry [33, 38, 40, 41, 59, 60]. Our work alerted chemists world-wide that this sort of transformation was feasible and our key review article [44] set the stage for further developments in this field.

Compared to fluorinated aromatics, the lack of suitable π-orbitals in totally saturated perfluorocarbons makes selective C-F bond activation even more of a challenge in these "Teflon" like compounds [62, 63]. Remarkably, we were able to achieve selective defluorination of some of these substrates using transition metal reagents based on low valent chromium, cobalt [45], iron[39], titanium [50] and zirconium[53] metallocenes. The prototypical reaction involves partial defluorination of perfluorodecalin ($C_{10}F_{18}$) to afford perflurornapthalene ($C_{10}F_8$) at room temperature but we have extended this chemistry to other substrates. We have demonstrated that the metallocences act as electron shuttles to reductively cleave the C-F bond and can make this process catalytic in metallocence with appropriate terminal reductants. I shared the ACS Nobel Laurate Signature Award in Graduate Education with my student Dr. Jaqueline Kiplinger for this work in 1998. Most recently we have discovered that classical coordination compounds such as tris-bipyridyl cobalt(I) can activate C-F bonds and the whole process made catalytic using sodium borohydride as the reductant. I am particularly proud to note that this work was accomplished by Vicky Mayall a high school chemistry teacher as part of her Master's project. This work has been validated and extended by another high school teacher in the MSSST program. In the case of cobaltocene, a useful source of "naked" fluoride is generated making it possible to transfer fluorine from one carbon to another in a one-pot flask [45].

Research in my lab is now largely conducted with undergraduate students. We continue to explore various aspects of C-F activation chemistry including extensive structural studies of model complexes relevant to the reductive chemistry of the C-F bond. We are also exploring model metal complexes relevant of C-F hydrolysis under acidic conditions. This may lead to controlled defluorination reactions of straight chain perfluorocarbons that are persistent in the environment. We now have definitive structural evidence for significant lengthening of C-F single bonds adjacent to a manganese carbonyl center in a series of fluorinated compounds. I have also made a number of contributions to the Chemical Education literature – often with undergraduate co-authors [35, 37, 47, 48, 55, 58, 61, 64, 65]. These projects provide excellent training for students; many of my former co-workers have gone on to top Ph.D. programs in the sciences or to Medical School.

PUBLICATIONS

(*Undergraduate Co-Authors)

*1. T. G. Richmond, J. R. Johnson, J. O. Edwards, and P. H. Rieger, Kinetics of Pyroarsenate Hydrolysis in Aqueous Solution, *Aust. J. Chem. 30*, 1187-1194 (**1977**).

*2. C. D. Baer, J. O. Edwards, M. J. Kaus, T. G. Richmond, and P. H. Rieger, Kinetics of an Associative Ligand Exchange Process: Alcohol Exchange with Arsenate(V) Triesters, *J. Am. Chem. Soc. 102*, 5793-5798 (**1980**).

3. S. B. Butts, T. G. Richmond, and D. F. Shriver, Acceleration of the Methyl Migration Reaction with Proton Acids, *Inorg. Chem. 20*, 278-280 (**1981**).

4. C. Y. Chang, C. E. Johnson, T. G. Richmond, Y. T. Chen, W. C. Trogler, and F. Basolo, Kinetics and Mechanism of Ligand Substitution in Iron Tricarbonyl 1, 4-Dimethyltetraazabutadiene, *Inorg. Chem. 20*, 3167-3172 (**1981**).

5. T. G. Richmond, F. Basolo, and D. F. Shriver, Bifunctional Activation of Coordinated Carbon Monoxide: A Kinetic Study of Lewis Acid Induced Alkyl Migration, *Inorg. Chem. 20*, 1272-1273 (**1981**).

6. Q. Z. Shi, T. G. Richmond, W. C. Trogler, and F. Basolo, Mechanism of Carbon Monoxide Substitution in a Metal Radical: Vanadium Hexacarbonyl, *J. Am. Chem. Soc. 104*, 4032-4034 (**1982**).

7. Q. Z. Shi, T. G. Richmond, W. C. Trogler, and F. Basolo, Kinetics and Mechanism of Ligand Substitution in Iron Tricarbonyl 1, 4-Diazabutadiene Complexes, *Organometallics 1*, 1033-1037 (**1982**).

8. T. G. Richmond, F. Basolo, and D. F. Shriver, Interaction of Metal Carbonyl Hydrides with Lewis Acids, *Organometallics 1*, 1624-1628 (**1982**).

9. T. G. Richmond, Q. Z. Shi, W. C. Trogler, and F. Basolo, Mechanism of Lewis Base Induced Disproportionation of Vanadium Hexacarbonyl, *J. Chem. Soc., Chem. Commun.* 650-652 (**1983**).

10. T. G. Richmond and D. F. Shriver, Facile Electrophilic Halogen Exchange Between Boron Trihalides and Transition Metal Perfluoroalkyl Complexes. A Novel Method for the Synthesis of Reactive Transition Metal α-Haloalkyl Complexes, *Organometallics 2*, 1061-1062 (**1983**).

11. Q. Z. Shi, T. G. Richmond, W. C. Trogler, and F. Basolo, Mechanism of Carbon Monoxide Substitution in Metal Carbonyl Radicals: Vanadium Hexacarbonyl and Its Phosphine Substituted Derivatives, *J. Am. Chem. Soc. 106*, 71-76 (**1984**).

12. T. G. Richmond, Q. Z. Shi, W. C. Trogler, and F. Basolo, Kinetics and Mechanism of Lewis Base Induced Disproportionation of Vanadium Hexacarbonyl and Its Phosphine Substituted Derivatives, *J. Am. Chem. Soc. 106*, 76-80 (**1984**).

13. Q. Z. Shi, T. G. Richmond, W. C. Trogler, and F. Basolo, Origin of the Exceptional Reactivity of Vanadiumpentacarbonylnitrosyl, *Inorg. Chem. 23*, 957-960 (**1984**).

14. T. G. Richmond and D. F. Shriver, Electrophilic Halogen Exchange Between Lewis Acids and Transition Metal Perfluoroalkyl Complexes. Synthesis and Characterization of Transition Metal α-Haloalkyl Complexes, *Organometallics 3*, 305-314 (**1984**).

15. T. G. Richmond, A. M. Crespi, and D. F. Shriver, Nucleophilic, Electrophilic and Homolytic Reaction Chemistry of Transition Metal Carbonyl Trihalomethyl (X = F, Cl, Br) Complexes, *Organometallics 3*, 314-319 (**1984**).

16. F. C. Anson, T. J. Collins, R. J. Coots, S. L. Gipson, and T. G. Richmond, Synthesis and Characterization of Stable Cobalt(IV) Coordination Complexes: Molecular Structure of *trans*-[1, 2-*bis*(3, 5-dichloro-2-hydroxybenzamido)-4, 5-dichlorobenzene]*bis*(4-*tert*-butylpyridine)cobalt(IV), *J. Am. Chem. Soc. 106*, 5037-5038 (**1984**).

17. T. J. Collins, T. G. Richmond, B. D. Santarsiero, and B. G. R. T. Treco, Paramagnetic Cobalt(III) Complexes of Polyanionic Chelating Ligands, *J. Am. Chem. Soc. 108*, 2088-2090 (**1986**).

18. B. S. Ault and T. G. Richmond, Matrix Isolation Investigation of the Interaction of Lewis Acids with Cr(CO)6 and Mo(CO)6, *Inorganica Chemica Acta 103*, 29-31 (**1987**).

19. F. C. Anson, T. J. Collins, T. G. Richmond, B. D. Santarsiero, J. E. Toth, and B. G. R. T. Treco, Highly Stabilized Copper(III) Complexes, *J. Am. Chem. Soc. 109*, 2974-2979 (**1987**).

20. T. J. Collins, S. Ozaki, and T. G. Richmond, Catalytic Oxidation of Styrene in the Presence of Square Planar Cobalt(III) Complexes of Polyanionic Chelating Ligands, *J. Chem. Soc., Chem. Commun.* 803-804 (**1987**).

*21. T. G. Richmond, M. A. King, E. P. Kelson, and A. M. Arif, Facile Chelate Assisted Carbon-Halogen Bond Cleavage at Tungsten(0), *Organometallics 6*, 1995-1996 (**1987**).

22. T. G. Richmond, C. E. Osterberg, and A. M. Arif, Activation of Carbon-Fluorine Bonds by Oxidative Addition, *J. Am. Chem. Soc. 109*, 8091-8092 (**1987**).

*23. T. G. Richmond, E. P. Kelson, and A. T. Patton, Polymeric Silver Coordination Complexes, *J. Chem. Soc., Chem. Commun.* 96-97 (**1988**).

*24. T. G. Richmond, E. P. Kelson, G. B. Carpenter, and A. M. Arif, Mechanism of Formation of Coordination Polymers: A Structural Model for Polymer Chain Growth, *J. Am. Chem. Soc. 110*, 2334-2335 (**1988**).

25. M. J. Poss, A. M. Arif, and T. G. Richmond, Regioselective Chelate Assisted Carbon-Halogen Bond Cleavage at Tungsten(0), *Organometallics 7*, 1669-1670 (**1988**).

26. C. E. Osterberg, A. M. Arif, and T. G. Richmond, Transition Metal Based Reagents for Molecular Recognition: Hydrogen Bonding Properties of Tungsten(II) *cis*-Amino Halides, *J. Am. Chem. Soc. 110*, 6903-6904 (**1988**).

27. M. R. Anderson, D. J. Blackwood, T. G. Richmond, and S. Pons, The Effect of Solvent Type on the Infrared Spectrum of Carbon Monoxide Adsorbed at Platinum Electrodes, *J. Electroanal. Chem. 256*, 397-403 (**1988**).

28. A. E. Russell, C. E. Osterberg, D. J. Blackwood, M. R. Anderson, T. G. Richmond, and S. Pons, The Activation of Carbon-Fluorine Bonds by Oxidative Addition at Tungsten(0): An Electrochemical Study, *J. Electroanal. Chem. 258*, 139-146 (**1989**).

29. R. Benn, A. Rufin'ska, C. E. Osterberg, M. A. King, and T. G. Richmond, 183W NMR Data ((183W) nJ(W,H), and **1**J(W,F)) of Tungsten(II)metallacycles via Two Dimensional Indirect (**1**H, 183W) NMR Spectroscopy, *J. Organomet. Chem. 376*, 359-366 (**1989**).

*30. H. Schumann, A. M. Arif, and T. G. Richmond, Synthesis and Reactivity of 1,2- and 1,4-Dihydroxy Arene Complexes of Chromium Tricarbonyl, *Polyhedron 9*, 1677-1681 (**1990**).

31. A. M. Arif and T. G. Richmond, A Silver Coordination Polymer Bridged by a Conjugated Ligand, *J. Chem. Soc., Chem. Commun.* 871-872 (**1990**).

32. C. E. Osterberg, M. A. King, A. M. Arif, and T. G. Richmond, Surprising Basicity of Low Valent Transition Metal Carbonyl Fluorides: Crystallographic Characterization of an sp2-CH...F Hydrogen Bond, *Angew. Chem. Int. Ed. Engl. 29*, 888-890 (**1990**).

33. B. P. Buffin and T. G. Richmond, Coordination Chemistry of Chelating Nitrogen Ligands with Tungsten Carbonyls, *Polyhedron 9*, 2887-2893 (**1990**).

34. T. G. Richmond, Hydrogen Bonding in Transition Metal Fluorides, *Coord. Chem. Rev. 105*, 221-251 (**1990**).

*35. B. Lucht, M. J. Poss and T. G. Richmond, Chelate Assisted Carbon-Halogen Bond Cleavage by Oxidative Addition at a Tungsten(0) Carbonyl Metal Complex: An Inorganic/Organometallic Laboratory Experiment for Advanced Undergraduates, *J. Chem. Educ. 68*, 786-788 (**1991**).

*36. B. Lucht, M. J. Poss, M. A. King, and T. G. Richmond, Tungsten(0) Inserts Into a Carbon-Fluorine Bond in the Presence of a Carbon-Hydrogen Bond, *J. Chem. Soc., Chem. Commun.* 400-401 (**1991**).

*37. J. Riley and T. G. Richmond, Redox Equations with an Infinite Number of Balanced Solutions, *J. Chem. Educ. 69*, 114-115 (**1992**).

38. R. G. Harrison, A. M. Arif, G. Wulfsberg, R. Lang, T. Ju, G. Kiss, C. D. Hoff, and T. G. Richmond, Crystallographic and Spectroscopic Assessment of Chelate Stabilized Aryl Halide Complexes at a Seven Coordinate d4 Metal Centre, *J. Chem. Soc., Chem. Commun.* 1374-1376 (**1992**).

39. R. G. Harrison and T. G. Richmond, Reductive Defluorination of Saturated Perfluorocarbons by Organometallic Nucleophiles, *J. Am. Chem. Soc. 115*, 5303-5304 (**1993**).

40. B. P. Buffin, M. J. Poss, A. M. Arif, and T. G. Richmond, Synthesis and Reactivity of a W(0) Anion Stabilized by Chelating Tertiary Amines. The Oxidative Addition and Reductive Elimination of a Carbon-Tin Bond at Tungsten(0), *Inorg. Chem. 32*, 3805-3806 (**1993**).

41. B. P. Buffin, A. M. Arif, and T. G. Richmond, Carbonyl Insertion and Reductive Elimination Chemistry of Tungsten(II) Alkoxides and Aryloxides, *J. Chem. Soc., Chem. Commun.* 1432-1434 (**1993**).

42. J. L . Kiplinger, M. A. King, A. M. Arif, Metal-Assisted Functionalization of Fluorocarbons: Alkyne Insertion Versus Carbon Monoxide Substitution in Tungsten(II) Metallacycles, *Organometallics 12*, 3382-3384 (**1993**).

43. T. G. Richmond and C. E. Osterberg, Activation of Carbon-Fluorine Bonds by Transition Metals, *ACS Symposium Series. Inorganic Fluorine Chemistry: Toward the 21st Century 555*, 392-404 (**1994**).

44. J. L. Kiplinger, T. G. Richmond, C. E. Osterberg, Activation of Carbon-Fluorine Bonds by Metal Complexes, *Chem. Rev. 94*, 373-431 (**1994**).

45. B. K. Bennett, R. G. Harrison, T. G. Richmond, Generation and Reaction Chemistry of Cobaltocenium Fluoride: A Novel Source of "Naked" Fluoride Formed by Carbon-Fluorine Bond Activation in Saturated Perfluorocarbons, *J. Am. Chem. Soc. 116*, 11165-11166 (**1994**).

46. J. L. Kiplinger, A. M. Arif, T. G. Richmond, A New Bonding Mode for Cyanoacetylene: A Tungsten(II) Fluoride Complex in which Cyanoacetylene Serves as a Four-Electron Donor Alkyne Ligand, *Inorg. Chem. 34*, 399-401 (**1995**). Errata: *Inorg. Chem. 35*, 6352 (**1996**).

47. T. G. Richmond, Demonstrating a *Lack* of Reactivity: A Chemical Frying Pan Illustrates the Resistance of Polytetrafluoroethene to Chemical Attack, *J. Chem. Educ. 72*, 731 (**1995**).

*48. J. A. Pergler, R. O. Ragsdale, T. G. Richmond, Crystallization of Supersaturated Sodium Acetate and the Temperature Dependence of the Autoionization Constant of Water, *J. Chem. Educ. 72*, 1027-1028 (**1995**).

49. S. D. Looman, T. G. Richmond, Oxidative Addition of Surface Bound Aryl Halides at Tungsten(0), *Inorg. Chim. Acta 240*, 479-484 (**1995**).

50. J. L. Kiplinger, T. G. Richmond, Group IV Metallocene Mediated Synthesis of Fluoroaromatics via Selective Defluorination of Saturated Perfluorocarbons, *J. Am. Chem. Soc. 118*, 1805-1806 (**1996**).

*51. S. D. Looman, S. Giese, A. M. Arif, T. G. Richmond, π-Basicity of the (Diamine)tricarbonyl-tungsten(0) Fragment Stabilizes η2-Aldehyde Complexes at Tungsten(0), *Polyhedron 15*, 2809-2811 (**1996**).

52. J. L. Kiplinger, T. G. Richmond, A. M. Arif, C. Dücker-Benfer, R. van Eldik, Synthesis and Characterization of Highly Fluorinated Tungsten(II) Metallacyclopropene Complexes. Kinetics and Mechanism of an Unprecedented η2-Vinyl Isomerization, *Organometallics 15, 1545-1565* (**1996**).

53. J. L. Kiplinger and T. G. Richmond, Selective Room Temperature Hydrogenolysis of Aromatic Fluorocarbons Mediated by a Low-Valent Zirconium Complex, *Chem. Commun.* 1115-1116 (**1996**).

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*55. G. Owens, T. G. Richmond, Demonstrating Catalysis with a Bang! Initiation of a Hydrogen / Oxygen Explosion With a Pd/C Catalyst, *The Chemical Educator 1*(4): S 1430-4171 (96) 04045-9; Avail. URL: http://journals.springer-ny.com/chedr (**1996**).

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*58. T. G. Richmond and A. Parr, A U - Tube Experiment to Discover the Curve in Boyle's Law, *J. Chem. Educ. 74*, 414-415 (**1997**).

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61. B. K. Bennett and T. G. Richmond, "A Inexpensive, Disposable Cannula Filtration Device," *J. Chem. Educ.* 75, 1034 (**1998**).

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63. T. G. Richmond, "Organometallic Transformations Demonstrate that Fluorocarbons are Reactive Molecules," *Angew. Chem. Int. Ed. Engl. 39*, 3241-3244 (**2000**); *Angew. Chem. 112*, 3378-3380 (**2000**).

*64. R. Huefner and T. G. Richmond, "All Titration Indicators are Not Created Equal - A Lecture Demonstration," *The Chemical Educator 5*, 181-182 (**2000**).

*65. C. S. Parraga, S. D. Brown and T. G. Richmond, "A Colorful Catalysis Demonstration," *The Chemical Educator 6*, 1-2 (**2001**).

MISCELLANEOUS PUBLICATIONS

1. General Chemistry (121-123) Laboratory Manual, Edited by R. W. Gedridge, Jr. and T. G. Richmond, 224 pages, **1987**.

2. "Graduate Study in Chemistry - Outlook for the 1990's," T. G. Richmond, ACS Student Affiliates Newsletter, Summer, **1990**, Vol. 22, No. 3, pp. 1-2.

3. "How to Apply for Graduate Study in Chemistry," T. G. Richmond, *In Chemistry, The Magazine for ACS Student Affiliates*, Vol. 2, No. 5, Summer, **1992**.

4. "*trans*-Dichloro Tetraamine Complexes of Ruthenium(III)" submitted by Chi-Ming Che, Tai-Chu Lau, and Chung-Kwong Poon, checked by J. Grantham and T. G. Richmond. *Inorganic Syntheses*, *29*, 164-167 (**1992**).

5. Commentary on "New Polyaza Tris-ferrocene and Tris-2,2'-bipyridyl Macrobicyclic Cryptand Molecules. Isolation of Homo- and Hetero-polymetallic Zinc(II) and Copper(I) Cryptates Containing Externally Coordinated Ruthenium(II) Cations," R. M. Barmore and T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry*, *4*, 156-159 (**1992**).

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7. Commentary on "Room-Temperature C-F Bond Activation of Hexafluorobenzene by a Tailor-Made Pt(0) Intermediate, [(dtbpm)Pt(0)]," R. G. Harrison and T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry*, *5*, 115-118 (**1993**).

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9. Commentary on "Selective Reduction of Saturated Perfluorocarbons, " T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry*, *5*, 180-183 (**1993**).

10. Commentary on "Catalytic Activation of Carbon-Fluorine Bonds by a Soluble Transition Metal Complex," T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry 6*, 39-44 (**1994**).

11. Commentary on "Reactions of [(C5Me5)ZrF3] with AlMe3 - Synthesis and Structure of a Zirconium - Aluminium - Carbon Cluster," T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry 6*, 35-38 (**1994**).

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14. "Are You Willing to Experiment? A Laboratory Guide for Elementary Chemistry," T. G. Richmond, 110 pages (**1994**); Revised (**1995**).

15. Commentary on "Evidence for the Formation of Free 16-Electron Species Rather than Solvate Complexes in the Ultraviolet Irradiation of CpCo(CO)2 in Liquefied Noble Gas Solvents," T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry 7*, 1-3 (**1995**).

16. "Graduate Departments Actively Recruit Students," Thomas G. Richmond and Ellen R. Fisher, *YCC Newsletter*, American Chemical Society, Fall, **1995**.

17. Commentary on "Organometallic Building Blocks for One-Dimensional Polymeric Structures," B. K. Bennett and T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry 10*, 121-124 (**1997**).

18. Commentary on "A C2 Symmetric Chiral Ketone for Catalytic Asymmetric Epoxidation of Unfunctionalized Olefins" and "Highly Enantioselective Epoxidation of *trans*-Stilbenes Catalyzed by Chiral Ketones," J. D. Van Horn and T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry, 11*, 89-94 (**1998**).

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21. Commentary on "Mono-, Di-, Tri-, and Tetracarbonyls of Copper(I), Including the Structures of Cu(CO)2(1-Bn-CB11F11) and [Cu(CO)4][1-Et-CB11F11]," A. Parr and T. G. Richmond *CHEMTRACTS, Inorganic Chemistry*, *13*, 103-107 (**2000**).

*22. Commentary on "Hydrodefluorination of Fluorobenzene and 1,2-Difluorobenzene under Mild Conditions over Rhodium Pyridylphosphine and Bipyridyl Complexes Thethered on a Silica Supported Palladium Catalyst," S. D. Brown and T. G. Richmond, *CHEMTRACTS, Inorganic Chemistry 13*, 134-138 (**2000**).

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INVITED LECTURES AT ACADEMIC INSTITUTIONS – 63

INVITED PRESENTATIONS AT PROFESSIONAL MEETINGS – 10

CONTRIBUTED PRESENTATIONS AT PROFESSIONAL MEETINGS – 57

Major "Faraday" Outreach Lectures (2012 – present) – 28 (Attendance Estimate: Approx. 6,000)

RECENT EXTERNAL GRANT SUPPORT

1. "Burn Test 2021," Toole Army Depot (2021), $32,000 (total costs)

2. "Burn Test 2019," Toole Army Depot (2019), $56,962 (total costs)

3. "Burn Test Chemicals," Toole Army Depot (2016), $10,454 (total costs)

4. "Environmental Burn Test Chemicals," Tooele Army Depot (2015), $25,555 (total costs)

5. "Incinerator Burn Test," Toole Army Depot (2013), $49,124 (37,019 Direct; 12,105 indirect)

6. "November Test Burn," Toole Army Depot (2010), $20,490 ($15,440 direct; $5,050 indirect)

7. "Furnace Test" Toole Army Depot (2008), $ 13,810 ($10.832 direct; $2978 indirect)

8. "DEAC Furnace Test," Toole Army Depot (2007), $38,142 ($29,915 direct; $8,227 indirect)

9. "EPA Test Chemicals," Crane Army Depot, (2007), $47,711 ($37,420 direct; 10,291 indirect)

10. "Burn Test Chemicals," Toole Army Depot (2006), $18,015 ($14,129 direct; $3,886 indirect)

11. “Gigascale Molecular Models,” Camille & Henry Dreyfus Foundation, $12,000.

12. “New Approaches to the Destruction of Environmentally Significant Fluorocarbons, University of Utah Research Foundation, $28,000, January 2005 – December 2005

THESIS TITLES

E. P. Kelson, B. S. (Honors), "Complexes with Potentially Quadridentate Ligands," 93 pages, June, 1988.

B. P. Buffin, M.S., "(I) Tungsten Carbonyl Complexes of Chelating Nitrogen Ligands; (II) Spectroscopic Studies of Hydrogen Bonding and Hindered Pentafluorophenyl Group Rotation in Titanocene Fluoride Derivatives," 124 pages, March, 1990.

C. E. Osterberg, Ph.D., "Coordination Chemistry of Low Valent Tungsten Carbonyl Fluorides," 201 pages, June, 1990.

M. J. Poss, Ph. D., "Synthetic and Mechanistic Studies of Chelate Assisted Oxidative Addition of Aryl Halides at Tungsten(0)," 257 pages, August, 1991.

R. M. Barmore, M. S., "Hydrogen Bonding Properties and Hydrolysis of Transition Metal Fluorocarbons," 49 pages, August, 1993.

B. P. Buffin, Ph. D., "The Chemistry of Tungsten(II) Halides That Contain a Saturated Monoanionic Tridentate [C,N,N'] Ligand," 246 pages, August, 1993.

R. G. Harrison, Ph. D., "(I) Reductive Defluorination of Saturated Fluorocarbons by Organometallic Reagents. (II) Aryl Halide Coordination to Tungsten(II) and Molybdenum(II) by Chelating Schiff Base Ligands," 164 pages, December, 1993.

J. M. Pleva, M. S., "Mechanism of the Reductive Elimination of Carbon-Tin Bonds in Tungsten(II) Complexes," 66 pages, August, 1994.

S. D. Looman, Ph. D., "Tungsten(II) and Tungsten(0) Carbonyl Amines: Oxidative Addition, Insertion and $\eta 2$ Coordination," 227 pages, August, 1995

J. L. Kiplinger, Ph. D. “Activation and Functionalization of Carbon-Fluorine Bonds by Transition Metal Complexes,” 265 pages, August, 1996.

B. K. Bennett, Ph. D., “Carbon-Fluorine and Carbon-Carbon Bond Activation and Formation By Cobalt and Chromium Complexes,” 198 pages, August, 1997.

J. A. Statler, M. S., “Discovery-Based Experiments in Basic Chemistry,” May, 2003.

S. O. Gines, M. S., “Small Scale Chemistry Labs,” May 2004.

L. S. Goff, M. S., "Note-Taking Outline and Paragraph Project: Questions Relevant to General Chemistry," May 2004.

N. Gunty, M.S., "Guided Notes & Performance Assessments (Projects) for Honors Intermediate Algebra with Trigonometry on the Junior High School Level," May, 2004.

B. Illum, M. S., "Learning Science Through the Use of an Outdoor Garden Classroom," May 2004.

D. M. Sill, M. S., "Learning Science Through the Use of an Outdoor Garden Classroom," May 2004.

N. L. Treasure, M. S., "Expanding and Enriching the Chemistry Curriculum with Computer Help Presentations and Website Integration, " May 2004.

R. W. Wagner, M.S., "Science Education: Teaching Against Gender Inequalities," August 2004.

S. D. Wihongi, M.S., "PowerPoint Presentations for High School Chemistry," December, 2004

M. T Weinstock, Honors BS, "Crystalline Proton Sources," May 2007

J. A. Taylor, M.S., "Formative Assessments in Chemistry," July, 2007.

W. Hewitt, Honors BS, "Activation of Fluorine-Carbon Bonds Through Manganese(I) Coordination," May 2008

J. Barrow, M.S., "Teaching Science as Inquiry," July, 2008

S. K. Ahmed, Honors BS, "Synthesis, Characterization, and Reactions of an Organometallic Acid Fluoride," May 2009

Shea Wickleson, M.S., "Untangling the Food Web," August 2011.

Vicky Mayall, M.S., "Breaking Carbon-Fluorine Bonds using Cobalt(I) Complexes," December 2012.

Brandon Bacon, Honors BS, "C-F Bond Activation and Functionalization of Fluoroarenes via Transition Metal Carbonyls: Synthesis Characterization and Reactions," August 2013.

Florence Fernandez, Honors BS, "Evaluation of Environmental Education in High School Science Courses Across Salt Lake City, Utah," May, 2015.

Janette Duffin, M.S., "Exploration into the Use of a Cobalt(II) Bipyridine Complex to Catalytically Activate Carbon-Fluorine Bonds," December 2016.

Anastasia S. Borodai, Honors BS, "Faraday@Home: Continuing Faraday from the "U" to the Youth," May, 2017.

Stephan Hall, M.S., "Dynamic NMR Studies of Perfluorodecalin," August, 2019.

Jeffrey A. Statler, Ph. D., "Enhancing Student Experiences In Chemistry Through The Use Of Learning Objectives, Interactive Demonstrations And Peer-Reviewed Writing-To-Learn Prompts," July, 2021