
Binghamton University
Department of Chemistry



Guide to
Undergraduate
Research
2009 -2010

INTRODUCTION

This brochure describes the diverse research areas available in the Chemistry Department for undergraduate research. Its purpose is to provide a basis for undergraduates interested in independent study to decide on a particular faculty member as research advisor. Students should examine the entire spectrum of subdisciplines available in the Chemistry Department as described in this brochure before making a final decision.

Undergraduate chemical education in the United States, and at SUNY Binghamton in particular, is designed to provide a sound theoretical understanding of the principles of chemistry through lecture courses and the application of these principles through laboratory courses. By its very nature, however, traditional chemistry courses cannot give an undergraduate the experience of working in a research group, in which current research areas are investigated using modern and sophisticated techniques. Furthermore, hands-on experience in a research group is essential for a student to gain the actual working knowledge required in an industrial, governmental, or academic research environment. For these reasons, the Chemistry Department offers Chem 397 (Independent Study) and Chem 497 (Advanced Independent Study) to provide undergraduates with this kind of research experience. Students considering a career in chemistry or related fields should seriously consider enrolling in these courses. For Chemistry majors, four credits of Chem 397 and twelve credits total of independent research can count toward satisfying the elective requirements for the BA and BS degree.

Chemistry 397 (Independent Study) provides an introduction to basic research. The actual format of the study will depend on the particular faculty research advisor, but typically will include a search of the relevant literature, an introduction to the pertinent experimental and/or computational methods, original research on a particular topic, and participation in research group meetings. Students who contribute significantly to a research project are included as coauthors in publications arising from the research.

Those students previously enrolled in Chem 397 may want to continue research on a more advanced level and enroll in Chem 497 (Advanced Independent Study). Chem 497 requires more extensive preparation than Chem 397, including a written summary of the proposed research. Students may wish to continue further with their research project and enroll in Chem 498 (Advanced Independent Study - Honors) during their last semester at Binghamton University. Chem 498 is the highest level of research an undergraduate can do. It is the baccalaureate equivalent of doctoral research, and requires a written thesis and defense of the thesis before a faculty committee.

Chem 397, 497 or 498

To apply for Chem 397, 497 or 498, undergraduates should follow these steps:

1. Obtain and read a description of the guidelines for Independent Study. The guidelines can be obtained from the Chemistry Department office (Science 2, room 236).
2. Peruse this brochure and identify several faculty members whose research interests you.
3. Make an appointment and talk with the faculty members about their research and about the opportunities for undergraduate independent research in their research groups.
4. Chose a faculty member willing to act as research supervisor.
5. Fill out an application for independent study (available in the Departmental office), have the faculty member sign the application, and submit the application to the Departmental office. A decision on the application is normally made within one week by the Chair of the Undergraduate Program Committee.

FACULTY RESEARCH INTERESTS

SUSAN BANE (S2 320, x72927)

Professor

Bioorganic and Biophysical Chemistry

Dr. Bane received her B.S. in Chemistry from Davidson College (1980) and Ph.D. in Biochemistry from Vanderbilt University (1983). She did postdoctoral research in Bioorganic Chemistry at the University of Virginia, joining the SUNY Binghamton faculty in 1985.

RESEARCH INTERESTS

My research interests are in Chemical Biology. Chemical Biology is a relatively new term used to describe the study of the chemistry that underlies all biological structure and processes. We use the principles, theories and tools that have been traditionally applied to small molecules and apply them to investigate biologically important systems. Consequently, we draw from diverse areas of chemistry and biology - ranging from computational chemistry to cell biology - to solve a biological problem.

The biological system that has been the core of our program is the microtubule. Microtubules occupy a central role in the life of a cell. Examine any cellular function that involves movement - division, directional migration, transport - and microtubules are likely to be found. Microtubules are the target for a number of clinically important drugs effective against a variety of disease states. For example, the *Vinca* alkaloids have been successfully used for many years to treat leukemia and related neoplasms. Taxol[®], which is also an antimicrotubule drug, has been described as one of the most important new anticancer drugs of the past 20 years. Taxol[®] quickly found its place in the chemical arsenal against cancer and is highly effective against some notoriously difficult tumors. Understanding the molecular interactions of these drugs with the microtubule receptor will spur the development of newer, more effective anticancer drugs.

TYPES OF RESEARCH EXPERIENCE AVAILABLE

Our studies require the use of protein biochemistry, synthetic organic chemistry, and spectroscopic (NMR, fluorescence, UV/vis and CD) techniques. An individual student's project will generally emphasize one of these areas, depending on the student's interest and the current needs of the program.

SPECIFIC PREREQUISITES

Courses: Introductory Chemistry (107 and 108 or 111), Chemistry 231, 332 and 335. For students with interest in the biological aspects of this work, a course in Biochemistry is recommended but not required.

Students interested in research in our lab should read the following reviews prior to meeting with Professor Bane:

K. H. Downing "Structural basis for the interaction of tubulin with proteins and drugs that affect microtubule dynamics." *Annual Review of Cell and Developmental Biology* **16**, 89-111, 2000.

E. Nogales "Structural insights into microtubule function." *Annual Review of Biochemistry*, **69**, 277-302, 2000.

PERSONAL

Appropriate interests, motivation and responsible commitment of time are essential. Students interested in

independent study should plan on spending at least two semesters in the research lab and expect to devote a minimum of 15 hours/week to research. In my lab, it is essential that a student have large blocks of time available between 9 am and 5 pm, as most experiments require at least 4 hours to perform.

A research lab is very different from a laboratory class. It is rare for an experiment to work the first time (or the second time or even the third time). The research student must be prepared and willing to engage in a great deal of troubleshooting!

RELEVANT PUBLICATIONS

"Design, synthesis, and bioactivity of simplified paclitaxel analogs based on the T-Taxol bioactive conformation." Thota Ganesh, A. Norris, Susan Bane, A. A. Alcaraz, James P. Snyder, and David G. I. Kingston (2006) *Bioorganic & Medicinal Chemistry*, **14**, 3447-3454.

"The Taxol pharmacophore and the T-Taxol bridging principle." D. G. I. Kingston, S. Bane and J. P. Snyder (2005). *Cell Cycle*, **4**, 279-289.

"The Bioactive Taxol Conformation on β -Tubulin: Experimental Evidence from Highly Active Constrained Analogs." Thota Ganesh, Rebecca C. Guza, Susan Bane, Rudravajhala Ravindra, Natasha Shanker, Ami S. Lakdawala, James P. Snyder, and David G. I. Kingston (2004) *Proc. Natl. Acad. Sci USA*, **101**, 10,006-10,011.

"A Fluorescence-Based High Throughput Assay for Antimicrotubule Drugs." Barron, D. M., Chatterjee, S. K., Ravindra, R., Roof, R., Baloglu, E., Kingston, D. G.I. and Bane, S. (2003) *Anal. Biochem.* **315**, 49-56.

"Interaction of Tubulin with a New Fluorescent Analogue of Vinblastine." Chatterjee, S. K., Laffray, J., Patel, P., Ravindra, R., Qin, Y., Kuehne, M. E. and Bane S. L. (2002) *Biochemistry* **41**, 14010-14018.

"Synthesis and Antimicrotubule Activity of Combretatropone Derivatives." Janik, M. E. and Bane, S. L. (2002) *Bioorg. Med. Chem.* **10**, 1895-1903.

"Baccatin III Induces Tubulin to Assemble into Long Microtubules" Chatterjee, S. K., Barron, D. M., Vos, S. and Bane, S. (2001) *Biochemistry* **40**, 6964-6970.

"Synthesis and Microtubule Binding of Fluorescent Paclitaxel Derivatives." Baloglu, E., Kingston, D. G. I., Patel, P., Chatterjee, S. K. and Bane, S. L. (2001) *Bioorg. Med. Chem. Lett.* **11**, 2249-2252.

"Synthesis and Biological Evaluation of Novel Macrocyclic Paclitaxel Analogs." Metaferia, B. B., Hoch, J., Glass, T. E., Bane, S. L., Chatterjee, S. K., Snyder, J. P., Lakdawala, A., Cornett, B. and Kingston, D. G. I. (2001) *Org. Lett.* **3**, 2461-2464.

"Distances Between the Paclitaxel, Colchicine and Exchangeable GTP Binding Sites on Tubulin." Han, Y., Malak, H., Chaudhary, A. G., Chordia, M. D., Kingston, D. G. I., and Bane, S. (1998) *Biochemistry* **37**, 6636-6644.

NIKOLAY DIMITROV (S2 G37, x74271)

Associate Professor of Chemistry and Materials Science

Interests in Analytical Chemistry, Materials Science, Electrochemistry, Corrosion

Dr. Nikolay Dimitrov received his PhD degree in chemistry from Bulgarian Academy of Sciences, Sofia, BULGARIA in 1993. He did his postdoctoral research in electrochemistry and corrosion of materials at Arizona State University (1996-1999). Next he was appointed as a research assistant professor at Arizona State University for the period 2000-2003. He joined the chemistry faculty at SUNY Binghamton in the fall of 2003.

RESEARCH INTERESTS

Kinetic and Thermodynamic Aspects of Thin Film Growth - NSF-CAREER Award

Surface defects corresponding to adatoms, vacancies, and steps together with misfit dislocations are known to interact with one another affecting and often dominating kinetic processes. This research examines various issues related to the role of defect interactions in determining thin-film growth modes. Most recently, a long-term research activity was established aimed at realizing multistep galvanic displacement processes for the growth of epitaxial metal films and successive layered assemblies of different metals and/or alloys. A proof-of-concept study, marked the beginning of the development of *a new thin film growth method realizing as an elementary step monolayer limited, galvanic displacement*. While displacement reactions have been used recently for sub-monolayer to a monolayer surface modification, *the new outcome that warrants the innovative aspect of our study is associated with the application of this strategy for metal thin film deposition*. This method, called Surface Limited Redox Replacement (SLRR) is now applied for growth of thin metal films of Ag, Cu and Pt by at least four research groups nationwide.

Chemical and Electrochemical Processing of Nanoscale Materials - funded by NSF-DMR

Dealloying is a solid-state separation process in which a selective dissolution serves for removal of the most electrochemically active constituent. This process results in the formation of a nanoporous sponge composed almost entirely of the more-noble alloy constituents. *In a newly proposed research*, chemical and electrochemical selective dealloying along with potential controlled cementation are employed to design a variety of porous structures at nanometer length scales. An ongoing collaboration with the University of South Australia is aimed at hydrophobizing the as processed porous substrates that owing to the periodical surface roughness will render them superhydrophobic (lotus leaf effect). Exploration of avenues for polymer imprinting of the generated surface morphologies is also intended as a part of this research.

Analytical Techniques Based on Underpotential Deposition of Metals

The underpotential deposition in the systems $\text{Cu}^{2+}/\text{Ag}_x\text{Au}(1-x)$ (111), $\text{Ag}^+/\text{Cu}_x\text{Au}(1-x)$ (111) and $\text{Pb}^{2+}/\text{Cu}-\text{Alpoly}$ was investigated as a function of the alloy composition. A linear dependence of the upd coverage on the composition was found in the case of ideal separation of the alloying constituents. A power law function was found to describe the upd as a function of the alloy composition in the case of a randomly mixed alloy. These findings were successfully applied as an analytical tool for determining the alloy composition of the investigated substrates. Most recently, an ongoing research realizes simultaneously taking place nitrate electroreduction and metal UPD on Cu substrates for the development of an accurate and high-sensitivity technique for analysis and monitoring of metal content in natural waters. A quantitative study and modeling work shed light on such scenario taking place on Cu(111) electrode at open circuit potential.

INTERESTED STUDENTS

Interested students must be highly motivated and able to devote at least 12-15 hours/week to the research. An experiment in our Lab would require at least four hours of uninterrupted time. Also, prospective students should have very good to excellent performance in the laboratory activities associated with the core chemistry courses.

MOST RECENT PUBLICATIONS

- L.T. Viyannalage, S. Bliznakov, and **N. Dimitrov**, *Electrochemical Method for Quantitative Determination of Trace Amounts of Lead*, *Analytical Chemistry A*, **2008**, *80*, 2042.
- S. Bliznakov, E. Lefterova, **N. Dimitrov**, K. Petrov, and A. Popov, *A study of the Al content impact on the properties of $MmNi_{4.4-x}Co_{0.6}Al_x$ alloys as precursors for negative electrodes in NiMH batteries*, *Journal of Power Sources*, **2008**, *176*, 381
- N. Vasiljevic, L.T. Viyannalage, **N. Dimitrov**, and K. Sieradzki *High resolution electrochemical STM: New structural results for underpotentially deposited Cu on Au(111) in acid sulfate solution*, *Journal of Electroanalytical Chemistry*, **2008**, *613*, 118
- **N. Dimitrov**, R. Vasilic, N. Vasiljevic, *A kinetic model for redox replacement of UPD layers*, *Electrochemical and Solid State Letters*, **2007**, *10(7)*, D79
- L.T. Viyannalage, R.Vasilic, and **N. Dimitrov**, *Epitaxial Growth of Cu on Ag(111) and Au(111) by Surface Limited Redox Replacement - An Electrochemical and STM Study*, *Journal of Physical Chemistry*, **2007**, *111*, 4036.
- N. Vasiljevic, L.T. Viyannalage, **N. Dimitrov**, N.A. Missert, and R.G. Copeland, *Oxidation of The Cu(100) Surface Induced by Local Alkalinization*, *Journal of the Electrochemical Society*, **2007**, *154*, 202.
- R.Vasilic, L.T. Viyannalage, and **N. Dimitrov**, *Epitaxial Growth of Ag on Au(111) by Galvanic Displacement of Pb and Tl Monolayers*, *Journal of the Electrochemical Society*, **2006**, *153(9)*, C648.
- N. Vasiljevic, **N. Dimitrov**, K. Sieradzki, *Pattern Organization on Cu(111) in Perchlorate Solutions*, *Journal of Electroanalytical Chemistry*, **2006**, *595*, 60.
- R.V. Kukta, N. Vasiljevic, **N. Dimitrov**, K. Sieradzki, *Self-assembly of paired nanoribbons*, *Physical Review Letters*, **2005**, *95*, 186103 (also selected for the November 7, 2005 issue of *Virtual Journal of Nanoscale Science & Technology*).
- T. Trimble, L. Tang, N. Vasiljevic, **N. Dimitrov**, M. van Schilfhaarde, C. Friesen, C.V. Thompson, S. C. Seel, J. A. Floro, K. Sieradzki, *Anion adsorption induced reversal of coherency strain*, *Physical Review Letters*, **2005**, *95*, 166106.
- R.Vasilic, N. Vasiljevic and **N. Dimitrov**, *Open Circuit Potential Stability of Pb UPD layer on Cu(111) Face*, *Journal of Electroanalytical Chemistry*, **2005**, *580(2)*, 203
- R. Vasilic, **N. Dimitrov**, *Epitaxial Growth by Monolayer-Restricted Galvanic Displacement*, *Electrochemical and Solid State Letters*, **2005**, *8(11)*, C173

JAMES A. DIX (S2 808, x72480)

Associate Professor

Physical Chemistry

James Dix, born and raised in Moline, Illinois, obtained a B.A. in chemistry from Grinnell College in 1971, and a Ph.D. in physical chemistry from UCLA in 1977. At UCLA he studied applications of magnetic resonance to membrane permeability. Dr. Dix joined the Biophysical Laboratory of Harvard Medical School in 1977 to continue research in membrane permeability and joined the Binghamton chemistry faculty in 1981. He spent the 1988-1989 academic year as a Visiting Associate Research Biophysicist of the Cardiovascular Research Institute of UCSF. He also was a Visiting Scientist, Theoretical Biology and Biophysics, at Los Alamos National Laboratory, 1995-1996.

RESEARCH INTERESTS

My research goal is to obtain a molecular description of the dynamical aspects of biophysical systems. Most recently, I have used computational chemistry to explore how molecules move in crowded biological environments, and to develop structure-activity relationships for inhibitor binding to transport proteins. I have also explored how computers and the Internet can be used to teach and learn chemistry.

Molecular Motion in Crowded Systems

Chemical reactions that occur in biological cells typically require that reactants diffuse together. In vitro, the diffusive motion is often described by Brownian motion. In vivo, however, the motion may not be Brownian because the intracellular milieu is crowded with organelles and proteins. We explore the effect of crowding on diffusive motion by creating a trajectory of a collection of molecules using a molecular dynamics program, then calculating the distance the molecules have moved as a function of time. According to Einstein, the average of the square of this distance (the mean squared distance) is proportional to time if the motion is Brownian; nonlinear concave downward plots indicate non-Brownian motion. Our results and a review of the literature indicate that except when there is a specific interaction between a diffusing solute and a crowding molecule, the motion is Brownian (James A. Dix and A.S. Verkman, "Crowding Effects on Diffusion in Solutions and Cells," *Ann. Rev. Biophysics* **37**, 247–263, 2008). Our method can also be used to analyze experimental data using models that are difficult to develop analytic equations from (James A. Dix, Erik F. Y. Hom, and A. S. Verkman, "Fluorescence Correlation Spectroscopy Simulations of Photophysical Phenomena and Molecular Interactions: A Molecular Dynamics/Monte Carlo Approach," *J. Phys. Chem. B* **110**, 1896–1906, 2006; Mazin Magzoub, Prashant Padmawar, James A. Dix, and A. S. Verkman, "Millisecond Association Kinetics of K⁺ with Triazacryptand-Based K⁺ Indicators Measured by Fluorescence Correlation Spectroscopy," *J. Phys. Chem. B* **110**, 21216–21221, 2006.)

Structure-Activity Relationships

If one looks at a collection of molecules that have some biological effect, one finds that some molecules are more active than others in eliciting the biological effect. We are investigating the structural and chemical determinants of molecular biological activity. Typically, the structure and electrostatic distribution of the molecules are estimated by solving the Schrödinger equation with standard computer programs. A visual inspection of the results sometimes reveals key shifts in electron distribution that are correlated with biological activity. Additional insight can be gained by performing conformational field analysis (CoMFA) giving a three-dimensional picture of areas where steric and electrostatic changes lead to increased biological activity. These methods were applied to a series of 4, 4'-substituted disulfonic stilbenes that inhibit anion transport through the anion transport protein AE1. Our results indicate that electronic shifts to the ends of the molecules govern inhibitory potency.

Educational Technology

The goal of this research project is to determine to what extent electronic methods can be used to teach and learn undergraduate chemistry. We focused initially on developing an electronic curriculum for introductory chemistry using the World Wide Web (James A. Dix, Robert A. Allendoerfer, Wayne E. Jones, Jr., Roy A. Lacey and Bernard J. Laurenzi, "An Electronic Curriculum for Introductory Chemistry," *J. Instructional Technology* **24**, 151-157, 1995). In collaboration with Wayne Jones at Binghamton, we have developed a curriculum prototype (Wayne E. Jones, Jr., James A. Dix and Robert D. Allendoerfer, "Teaching chemistry on the World Wide Web: An interactive Internet learning environment for introductory chemistry," ACS symposium, New Orleans, March 24-25, 1996) that was used at SUNY Binghamton and SUNY Buffalo in the Fall semester, 1996. We also have created a CD-ROM that was ancillary to Ebbing and Gammon's *General Chemistry* textbook (<http://hmchem2.clt.binghamton.edu/>).

DAVID C. DOETSCHMAN (S2 B28B, x72298)

Professor

Materials and Physical Chemistry

With a B.S. from Northern Illinois University, and a Ph.D. from the University of Chicago, Dr. Doetschman was a research fellow at the Australian National University and at the University of Leiden (Netherlands) with Professor J. H. van der Waals. He joined the Binghamton faculty in 1975. He was Scientist-in-Residence at the Argonne National Laboratory Chemistry Division, Visiting Fellow at University College London, 1989-90 and Visiting Fellow at the Australian National University in 1998.

RESEARCH INTERESTS

Dr. Doetschman's research program is aimed mainly at a better understanding of the structure, motions, and chemistry of materials in the solid state through the application of appropriate spectroscopic techniques. His laboratory has gas chromatographic mass spectrometric (GC-MS), Fourier transform infrared (FT-IR), and electron paramagnetic resonance (EPR) instrumentation.

Current research is focusing on the nucleophilic reactions of Faujasite zeolites with various adsorbed organic compounds, some of which have environmental or security significance. Additionally, the group is studying the binding to the zeolite cage wall of polar organic molecules and free radical molecules with an array of spectroscopic techniques, including GC-MS, FT-IR, and EPR spectrometries.

RELEVANT PUBLICATIONS

"Nucleophilic Chemistry of X-type Faujasite Zeolites with 2-Chloroethyl Ethyl Sulfide (CEES), a Simulant of Common Mustard Gas," Charles W. Kanyi, David C. Doetschman, Jürgen T. Schulte, *Microporous and Mesoporous Materials*, **124**, 232-235 (2009).

"The Nucleophilic Chemical Reactions of NaX Faujasite Zeolite with Diisopropyl Fluorophosphonate (DFP)," Charles W. Kanyi, David C. Doetschman, Szu-Wei Yang, and Jürgen T. Schulte, *Microporous and Mesoporous Materials*, **119**, 23-29 (2009).

"The Chemistry of Alkyl Dihalides in Zeolite NaX at Room Temperature," Charles W. Kanyi, David C. Doetschman, and Jürgen Schulte, *Microporous and Mesoporous Materials*, **117**, 48-54 (2009).

"Room Temperature Reactions of Alkyl Halides in Zeolite NaX: Dehalogenation versus Dehydrohalogenation," C. W. Kanyi, D. C. Doetschman*, S.-W. Yang, J. S., and B. R. Jones, *Microporous & Mesoporous Materials*, **108**, 103-111 (2008).

"Multiple Effects of the Presence of Water on the Nucleophilic Substitution Reactions of NaX Faujasite Zeolite with Dimethyl Methylphosphonate (DMMP)," Justin B. Sambur, David C. Doetschman*, Szu-Wei Yang, Jürgen T. Schulte, Barry R. Jones, and Jared B. DeCoste, *Microporous and Mesoporous Materials*, **112**, 116-124 (2008).

"Vanadium(I) Chloride and Lithium Vanadium(I) Dihydride as Epimetallating Reagents for Unsaturated Organic Substrates: Constitution and Mode of Reaction," John J. Eisch, Paul. O. Fregene, and David C. Doetschman, *Eur. J. Org. Chem.* **2008**, 2825-2835 (2008).

"Effects of Cation Siting and Spin-Spin Interactions on the Electron Paramagnetic Resonance (EPR) of Cu²⁺ Exchanged X Faujasite Zeolite," C. O. Kowenje, B. R. Jones, D. C. Doetschman, S.-W. Yang, C. W. Kanyi, *Chemical Physics* **330**, 401-409 (2006).

“Infrared Vibrational Spectra of *tert*-Butyl Halides in Low-Aluminum HY Faujasite. Vibrational Excitation Exchange and Other Effects of Guest-Host Interactions,” J. D. Fox, *Chemical Physics*, **325**, 265-277 (2006).

“Sodium X-Type Faujasite Zeolite Decomposition of Dimethyl Methylphosphonate (DMMP) to Methylphosphonate. Nucleophilic Zeolite Reactions I,” Szu-Wei Yang, David C. Doetschman*, Jürgen T. Schulte, Justin B. Sambur, Charles W. Kanyi, Jack D. Fox, Chrispin O. Kowenje, Barry R. Jones, and Neesha D. Sherma, *Microporous & Mesoporous Materials*, **92**, 56-60 (2006).

“Linear, Primary Monohaloalkane Chemistry in NaX and NaY Faujasite Zeolites with and without Na⁰-Treatment. Zeolites as Nucleophilic Reagents II,” Charles W. Kanyi, David C. Doetschman*, Jürgen T. Schulte, Kaking Yan, Richard E. Wilson, Barry R. Jones, Chrispin O. Kowenje, and Szu-Wei Yang, *Mesoporous and Microporous Materials*, **92**, 292-299 (2006).

JOHN J. EISCH (S2 328, x74261)

Distinguished Professor of Chemistry

Organic, Organometallic and Inorganic Chemistry

Dr. Eisch received his B.S. degree, summa cum laude, from Marquette University (1952) and his Ph.D. degree with Professor Henry Gilman from Iowa State University (1956). He was Postdoctoral Fellow with Nobel Laureate Professor Karl Ziegler, Max Planck Institute (Mülheim), Germany (1956 -1957), a European Research Associates Fellow, Brussels, Belgium (1957), and Research Fellow of the Japan Society for the Promotion of Science (1979). He received the Alexander von Humboldt Senior Scientist Research Award, Universität München, Germany (1993-1996) and the First Henry Gilman Research Award, Iowa State University (1995). In 2002 he was awarded the degree, Doctor of Science, honoris causa, by Marquette University. During the 2005-2006 academic year he was visiting professor at the Institute of Inorganic Chemistry of the Technical University, Munich, Germany under a continuing Humboldt Senior Scientist Research Award and presented scientific lectures at 12 other German universities and research institutes.

RESEARCH INTERESTS

Our current research embraces a variety of synthetic and mechanistic studies in organometallic and heterocyclic chemistry. Our interests in organometallic chemistry include the following aspects: 1) the stereoselective formation of carbon-carbon and carbon-hydrogen bonds by means of magnesium or aluminum alkyls; 2) fundamental studies of Ziegler-Natta catalytic alkylations and oligomerizations, essential to industrial polymer and hydrocarbon technology; 3) the utility of subvalent organonickel reagents in organic synthesis, especially in the homogeneous desulfurization of sulfides and thiols (important for future chemical processes based on coal); 4) the generation of subvalent early transition metal reductants and their utility in organic synthesis and catalysis; 5) unusual pericyclic or anionic rearrangements, such as those of boron and aluminum; and 6) formation and reactions of three-membered metallocycles or epimetallated unsaturated hydrocarbon adducts, generated by adding subvalent transition metal salts to C=C, C=O, C=N and C≡C linkages. In the last 14 years over 50 papers have described this novel chemistry.

In heterocyclic studies we have been concerned with the synthesis and properties of unusual rings containing metals or nitrogen as ring constituents. Illustrative are five-membered (borole) and seven-membered (borepin) boron rings, which display antiaromatic and aromatic character, respectively. Furthermore, nitrogen heterocycles isoelectronic with azulenes have been found to display chromoisomerism (tautomeric equilibria between colorless and highly colored isomers), and the highly reactive, antiaromatic dibenzazapentalene has been synthesized for the first time. The results of such studies are expected to shed light on pi-electron interactions between carbon centers and various potential pi-bonding metals or nitrogen centers.

A most recent developing interest in our research has been a study of how a prebiotic pool of amino acids, sugars and lipids were evolved on the prebiotic earth, thereby setting the stage for the chemical evolution of the RNA World and the emergence of Life. Particular current attention has been given to the elaboration of sugar alcohols from the transition metal-catalyzed, photochemical redox reactions of formaldehyde.

SELECTED PUBLICATIONS (from 365)

“Attempted Generation of the Potentially Aromatic 6,7-Diphenyldibenzo[e,g][1,4]-diazocine Dianion Leads with Profound Rearrangement to the Isomeric N-(2-Amino-1,2-Diphenylethenyl)carbazole Dianions”, J.J. Eisch, R.N. Manchanayakage and A.L. Rheingold, Org. Lett., accepted for publication (2009).

"Vanadium(I) Chloride and Lithium Vanadium(I) Dihydride as Selective Epimetallating Reagents for π - and σ -Bonded Organic Substrates", J.J. Eisch and P.O. Fregene, Eur. J. Org. Chem., 4482-4492 (2008).

"Vanadium(I) Chloride and Lithium Vanadium(I) Dihydride as Epimetallating Reagents for Unsaturated Organic Substrates: Constitution and Mode of Reaction", J.J. Eisch, P.O. Fregene and D.C. Doetschman, Eur. J. Org. Chem., 2825-2835 (2008).

"Purported Synthesis of 3,4,7,8-Tetraphenyl-1,2,5,6-Tetraazocine from Benzil and Hydrazine: Competing Cyclizations and Carbon-Carbon σ -Bond Scissions", J.J. Eisch, T.Y. Chan and J.N. Gitua, Eur. J. Org. Chem., 392-397 (2008).

"The Epimetallation and Carbonation of Carbonyl and Imino Derivatives: Epivanadation Route to 2-Amino and 2-Hydroxy Acids", J.J. Eisch, P.O. Fregene and J.N. Gitua, J. Organomet. Chem., **692**, 4647-4653 (2007).

"A Cautionary Tale on Reproducibility", J.J. Eisch and B. Halford, Chem. & Eng. News, January 22, 2007, **85**, 36 (2007).

"Nickel(II)-Carbene Intermediates in Reactions of Geminal Dihaloalkanes with Nickel(0) Reagents and the Corresponding Carbene Capture as the Phosphonium Ylide", J.J. Eisch, Y. Qian and A.L. Rheingold, Eur. J. Inorg. Chem., 1576-1594 (2007).

"Illuminating the Unexpected Benzylic Carbon-Carbon Bond Cleavage of Arylated Ethanes with Di-*n*-Butylzirconium Diethoxide by Illumination: Transfer Epizirconation as Exclusively a Photochemical Process", J.J. Eisch and J.N. Gitua, Organometallics, **26**, 778-779 (2007).

The Transient Titanocene(II): Direct Synthesis from Solvated Titanium(II) Chloride and Cyclopentadienylsodium and Ensuing Interception with Diphenylacetylene as 1,1-Bis(cyclopentadienyl)-2,3,4,5-tetraphenyltitanacyclopentadiene", J.J. Eisch, A.A. Adeosun and J. M. Birmingham, Eur. J. Inorg. Chem., 39-43 (2007).

"Direct Epimetallation of π -Bonded Organic Substrates with Titanium(II) Isopropoxide: Intermediacy of Biradical, Oligomeric Titanium(II) Reagents," J.J. Eisch, J.N. Gitua and D.C. Doetschman, Eur. J. Inorg. Chem., 1968-1975 (2006).

"Unexpected Benzylic Carbon-Carbon Bond Cleavage by Transfer Epizirconation: Indications of an SET Pathway and Implications for Alkane Metathesis," J.J. Eisch, S. Dutta and J.N. Gitua, Organometallics, **24**, 6291-6294, (2005).

"The Extraordinary Cocatalytic Action of Polymethylaluminumoxane (MAO) in the Polymerization of Terminal Olefins by Metallocenes: Chemical Change in the Group 4 Metallocene Dimethyl Induced by MAO", J.J. Eisch, P.O. Otieno, J.N. Gitua and A.A. Adeosun, Eur. J. Org. Chem., 4364-4371 (2005).

"Carbon-Carbon Bond Formation in the Surprising Rearrangement of Diorganylzirconium Dialkoxides: Linear Dimerization of Terminal Olefins", J.J. Eisch and S. Dutta, Organometallics, **24**, 3355-3358 (2005).

"New Syntheses of *ansa*-Metallocenes or Unbridged Substituted Metallocenes by the Respective Reductive Dimerization of Fulvenes with Group 4 Metal Divalent Halides or with Group 4 Metal Dichloride Dihydrides", J.J. Eisch, F.A. Owuor and X. Shi, Polyhedron, Symposium-in-Print, **24**, 1325-1339 (2005).

"The Decomposition of Transition Metal Alkyls Revisited: Surprising Wellspring of Novel Reagents for Organic Synthesis", J.J. Eisch, A.A. Adeosun, S. Dutta and P.O. Fregene, Eur. J. Org. Chem., 2657-2670 (2005).

"Novel Alkylidenating Agents via the α -Lithiation of Monoalkyl Group 4 Metal Derivatives: Methylidene-Metal Complexes and their Active Lithiated Precursors", J.J. Eisch and A.A. Adeosun, Eur. J. Org. Chem., 993-997 (2005).

JIYE FANG (S2 G33, x73752)

Associate Professor

Materials Chemistry, Nanotechnology

Dr. Fang earned his B.Sc. and M.Sc. in Chemistry from Lanzhou University (China) in 1984 and 1989, respectively. He then received his M.Sc. (Chemistry) and Ph.D. (Materials Science) degrees from the National University of Singapore (Republic of Singapore). He did postdoctoral research in Nanomaterials and Advanced Thermoelectric Materials at the University of New Orleans. Before joining the SUNY Binghamton in 2006, he has served as Chemistry faculty at the University of New Orleans for 4 years. Dr. Fang is a NSF CAREER winner in 2005.

RESEARCH INTERESTS

Materials Chemistry is an exciting, interesting intersection of modern materials science and chemistry with unlimited career opportunities. Dr. Fang's interdisciplinary research is focused on synthesis and manipulation of nanoscaled functional materials via a wet-chemical pathway, as well as understanding of the relevant physical and chemical phenomena on these size- and shape-controlled low-dimensional materials. The emphases are (1) to produce high-quality nanocrystals and to challenge advanced processing technology; (2) to investigate novel performance of monodisperse nanocrystals and their growth mechanism; (3) and to explore novel applications in emerging fields such as energy, fuel cell catalysts, bio-imaging and thermoelectric materials.

His synthetic strategy is based on a high-temperature organic solution approach, in which various chemical reactions are designed using organometallic precursors and carried out in an organic solvent at high reaction temperature in the presence of appropriate capping ligand and stabilizing agent. In other words, developed techniques that used to use in Organic Synthesis (e.g. air-/moisture-sensitive operation) are adopted to produce inorganic nanocrystals with well-defined high-quality (size-, shape-, phase- and composition-control). Knowledge from Coordination Chemistry, Organometallic Chemistry, Crystallography and Colloidal Processing may add an advantage to this study. Training of characterization skills such as phase/nanostructural (e.g. XRD, TEM, SEM, AFM), optical (e.g. UV-Vis, FTIR, PL), magnetic (e.g. SQUID, VSM, EPR), thermal (e.g. TGA, DTA), dielectric, chemical and thermoelectric investigations will also be involved.

Presently, the on-going research projects include (1) synthesis of diluted magnetic semiconductor quantum dots and investigation of their packing structure; (2) development of enhanced thermoelectric materials and study of their applications; (3) self-assembly of functional nanocrystals and structural study of superlattice (2D and 3D); and (4) wet-chemical fabrication of core-shell nanoparticles and bio-functional nanoparticles, and exploration of biological/medicine applications. His research is supported by NSF, DOE and private companies. For more information, please refer to <http://www.chem.binghamton.edu/FANG/>

RELEVANT PUBLICATIONS

"The First Synthesis of $Pb_{1-x}Mn_xSe$ Nanocrystals", Tianhao Ji, Wen-Bin Jian and Jiye Fang, *J. Am. Chem. Soc.*, 125(28), 8448-8449 (2003).

"Shape-Evolution and Self-Assembly of Monodisperse PbTe Nanocrystals", Weigang Lu, Jiye Fang, Kevin L. Stokes and Jun Lin, *J. Am. Chem. Soc.*, 126 (38), 11798 - 11799 (2004).

"Perfect Orientation Ordered *in-situ* One-Dimensional-Self-Assembly of Mn-doped PbSe Nanocrystals", Weigang Lu, Puxian Gao, Wen Bin Jian, Zhong Lin Wang and Jiye Fang, *J. Am. Chem.*

Soc., 126(45), 14816-14821 (2004).

“Single Crystalline Magnetite Nanotubes”, Zuqin Liu, Daihua Zhang, Song Han, Chao Li, Bo Lei, Weigang Lu, Jiye Fang and Chongwu Zhou, *J. Am. Chem. Soc.*, 127, 6-7 (2005).

“Study of Quasi-Monodisperse In₂O₃ Nanocrystals: Synthesis and Optical Determination”, Qingsheng Liu, Weigang Lu, Aihui Ma, Jingke Tang, Jin Lin and Jiye Fang, *J. Am. Chem. Soc.*, 127(15), 5276-5277 (2005).

“Bismuth Telluride Hexagonal Nanoplatelets and Their Two-Step Epitaxial Growth”, Weigang Lu, Yong Ding, Yuxi Chen, Zhong Lin Wang and Jiye Fang, *J. Am. Chem. Soc.*, 127(28), 10112 - 10116 (2005).

“Co-reduction Colloidal Synthesis of III-V Nanocrystals: The Case of InP”, Zhaoping Liu, Amar Kumbhar, Dan Xu, Jun Zhang, Zhaoyong Sun and Jiye Fang, *Angew. Chem. Int. Ed.* 47 (19) 3540-3542 (2008).

“p-Type Field-Effect Transistors of Single-Crystal ZnTe Nanobelts”, Jun Zhang, Po-Chiang Chen, Guozhen Shen, Jibao He, Amar Kumbhar, Chongwu Zhou and Jiye Fang, *Angew. Chem. Int. Ed.* 47(49) 9469-9471, (2008).

“Simple Cubic Super Crystals Containing PbTe Nanocubes and Their Core-Shell Building Blocks”, Jun Zhang, Amar Kumbhar, Jibao He, Narayan Chandra Das, Kaikun Yang, Jian-Qing Wang, Howard Wang, Kevin L. Stokes and Jiye Fang, *J. Am. Chem. Soc.*, 130 (45) 15203-15209, (2008).

“Super-Crystal Structures of Octahedral c-In₂O₃ Nanocrystals”, Weigang Lu, Qingsheng Liu, Zhaoyong Sun, Jibao He, Chidi Ezeolu and Jiye Fang, *J. Am. Chem. Soc.*, 130 (22) 6983-6991, (2008).

“Solution-Based Evolution and Enhanced Methanol Oxidation Activity of Monodisperse Pt-Cu Nanocubes”, Dan Xu, Zhaoping Liu, Hongzhou Yang, Qingsheng Liu, Jun Zhang, Jiye Fang, Shouzhong Zou and Kai Sun, *Angew. Chem. Int. Ed.* 48 (23) 4217-4221, (2009).

CHRISTOF T. GREWER (S2 816, x73250)

*Associate Professor
Biophysical Chemistry*

Dr. Grewer received his Ph.D. in Physical Chemistry from the University of Frankfurt, Germany, in 1993. He subsequently was a Postdoctoral Fellow at Cornell University and a Senior Research Associate at the Max-Planck-Institute for Biophysics in Frankfurt, Germany. He is joining the BU faculty in 2008 after a 4-year appointment as Assistant Professor in the Department of Physiology and Biophysics at the University of Miami School of Medicine.

RESEARCH INTERESTS

My laboratory focuses on research in the field of Biophysical Chemistry, at the interface between the chemical, biological, and physical sciences. We are interested in elucidating the physical principles underlying the movement of ions and small, organic molecules across biological membranes. In living cells, specific membrane proteins, such as ion channels and transport proteins, catalyze transmembrane movement of ions and organic molecules. We are specifically interested in transporters that “pump” substrates uphill against a transmembrane concentration and/or electrical gradient, by coupling this movement to an energy source. Proteins performing such tasks are called active transporters.

Transporters studied in the lab: Our current research focuses mainly on secondary-active Na⁺-coupled transporters, which are energized by coupling of substrate transport to the cotransport of Na⁺ ions down their electrochemical potential gradient across the membrane. Neurotransmitter transporters and amino acid transporters belong to this class of transport proteins. The systems investigated are: Glutamate transporters, γ -aminobutyric acid transporters, dopamine transporters, and neutral amino acid transporters (system ASC, system A, system N). Most of these transport systems are highly relevant for physiological processes, including chemical signal transmission in the brain, and they may be targets for future drug development.

Techniques: In many cases, transmembrane transport is associated with stationary or transient transport of charge. We measure this charge transport with electrophysiological techniques, such as current recording from transporter-expressing, voltage-clamped cells or patches excised from the cell membrane. In order to investigate transient charge transport, we perturb a pre-existing transporter steady state by applying voltage or rapid substrate concentration jumps and subsequently measuring the kinetics of the relaxation to a new steady state with a sub-millisecond time resolution. In addition to investigating the transport mechanism of wild-type transporters, rapid kinetic studies are extended to transporters that are fused to fluorescent proteins or site-specifically mutated. The combination of these techniques allows us to understand the relationship between the structure and the function of the transport proteins. The experimental techniques are supplemented with kinetic modeling to simulate transporter function and predict transporter behavior in their physiological environment.

Development of caged compounds: To apply substrate concentration jumps on such a fast time scale, amino acids or neurotransmitters are photochemically released from a photolabile, inactive caged precursor (caged amino acid) by a brief pulse of laser light. When using a suitable caging

group, for example the α -carboxy-o-nitrobenzyl caging group (CNB), photolysis takes place within 100 μ s. Our lab is currently actively involved in developing new photolabile caging groups and caged amino acids. We have recently synthesized and applied caged alanine and proline derivatives.

RECENT PUBLICATIONS

Zhang Z, Albers T, Fiumer H, Gameiro A, Grewer C. A conserved Na⁺ binding site of the sodium-coupled neutral amino acid transporter 2 (SNAT2). *J. Biol. Chem.*, (2009) in press.

Tao Z, Gameiro A, Grewer C. Thallium ions can replace both sodium and potassium ions in the glutamate transporter excitatory amino acid carrier 1. *Biochemistry*. (2008) 47, 12923-30.

Grewer C, Gameiro A, Zhang Z, Tao Z, Braams S, Rauen T. Glutamate forward and reverse transport: from molecular mechanism to transporter-mediated release after ischemia. *IUBMB Life*. (2008) 60, 609-19.

Zhang Z, Gameiro A, Grewer C. Highly conserved asparagine 82 controls the interaction of Na⁺ with the sodium-coupled neutral amino acid transporter SNAT2. *J Biol Chem*. (2008) 283,12284-92.

Erreger K, Grewer C, Javitch JA, Galli A. Currents in response to rapid concentration jumps of amphetamine uncover novel aspects of human dopamine transporter function. *J Neurosci*. (2008) 28, 976-89.

Zhang, Z., Tao, Z., Gameiro, A., Barcelona, S., Braams, S., Rauen, T., and Grewer, C., The transport direction determines the kinetics of substrate transport by the glutamate transporter EAAC1. *Proc. Natl. Acad. Sci. USA* (2007) 104, 18025-30.

Tao, Z., and Grewer, C., Cooperation of the conserved aspartate 439 and bound glutamate is important for forming a high-affinity Na⁺ binding site on the glutamate transporter EAAC1. *J. Gen. Physiol.*, (2007) 129, 331-344.

Zhang, Z. and Grewer, C., The sodium-coupled neutral amino acid transporter SNAT2 mediates an anion leak conductance that is differentially inhibited by transported substrates. *Biophys. J.* (2007) 92, 2621-2632.

Maier, W., Schemm, R., Grewer, C., and Laube, B., Disruption of interdomain interactions in the glutamate binding pocket affects differentially agonist affinity and efficacy of NMDA receptor activation. *J. Biol. Chem.* (2007) 282, 1863-1872.

Tao, Z., Zhang, Z., and Grewer, C., Neutralization of the aspartic acid residue D367, but not D454, inhibits binding of Na⁺ to the glutamate-free form and cycling of the glutamate transporter EAAC1. *J. Biol. Chem.* (2006) 281, 10263-10272.

WAYNE E. JONES, JR. (S2 609, x72421)

Professor

Inorganic Chemistry

Dr. Jones received a B.S. (Honors) degree from St. Michael's College in Vermont in 1987. He received his Ph.D. in Inorganic Chemistry in 1991 under the supervision of Professor Thomas J. Meyer at the University of North Carolina at Chapel Hill. After 18 months of post-doctoral work with Professor Marye Anne Fox at the University of Texas, he declined an NIH post-doctoral fellowship to join the faculty at Binghamton in the fall of 1993. He completed a sabbatical year as a visiting professor at the University of Pennsylvania in 2000 with Nobel Prize Winner Alan MacDiarmid.

RESEARCH INTERESTS

Dr. Jones's research interests involve the study of photo-induced electron and energy transfer in inorganic complexes, materials and polymers. By combining novel synthetic strategies with modern spectroscopic and characterization techniques, we gain a better understanding of fundamental processes which occur in all of chemistry including electron transfer, energy transfer, excited state reactivity, and materials design at a molecular level. The focus of our efforts is the design and study of molecular wires and devices. These nanomaterials provide a foundation for both fundamental investigations as well as opportunities for new applied technologies including sensors and electronics packaging. The projects briefly outlined below have been supported by grants from NIH, NSF, SRC, NIST, ONR, New York State Center for Advanced Technology (IEEC), and industrial partners. Undergraduate students work on each of these projects and are welcome to discuss research opportunities anytime after they have taken general chemistry.

One area of recent interest involves the preparation of conjugated polymer systems for long range electron and energy transfer. The application of electronic polymers to specific devices is currently being explored. We have prepared a series of fluorescent conjugated polymer chemosensors. This project has demonstrated the application of molecular wires for the detection of nanomolar quantities of transition metals in solution. Current efforts, supported by the National Institute of Health, are preparing new more reversible and water sensitive versions of this exciting new class of materials. Of particular interest is the non-linear quenching response in these polymers which make them significantly more sensitive than monomeric sensors. We have developed a unique mathematical model for this energy transfer process which, for the first time, allows distinction between Dexter and Forster energy transfer mechanisms. We are also working with Dr. Michael Wolf at the University of British Columbia on the design of more selective receptors based on hemi-labile ligands. This also involves detailed photophysical investigations of a series of transition metal complexes based on this dynamic Lewis basic ligand.

The design of molecular wires continues to be a fascinating target of chemistry, physics, and materials science. We have been applying a non-mechanical electrostatic polymer processing procedure to prepare nanofibrous materials with diameters of < 100 nm. The exploration of conducting polymers, blends, and in-situ deposition coating procedures provides for a range of new chemical and physical phenomena to be explored including nanoscale effects on conductivity, chemosensor behavior, and surface chemistry. Recently, this work has resulted in the development of a template based approach to the chemical preparation of tubular materials where the inner diameter of the tube is ~ 500 nm and the wall of the tube is ~ 50 nm. Chemical approaches to prepare metallic and conducting polymer tubes have been developed. These nanomaterials demonstrate enhanced electrical and thermal behavior and have recently been incorporated into polymer composites as next generation thermal interface materials for electronic devices.

RECENT PUBLICATIONS

“Competition between Energy Transfer Quenching and Chelation Enhanced Fluorescence in a Cu(II) Coordinated Conjugated Polymer System.” Lijuan Fan, Justin J. Martin, Wayne E. Jones Jr., *J. Fluorescence*, 2009, 19, 555-559.

“Fluorescent Conjugated Polymer Molecular Wire Chemosensors for Transition Metal Ion Recognition and Signaling.” Li-Juan Fan, Yan Zhang, Clifford B. Murphy, Sarah E. Angell, Matthew F.L. Parker, Brendan R. Flynn, Wayne E. Jones, Jr., *Coord. Chem. Reviews*, 2009, 253(3-4), 410-422.

“Synthesis and Optical Properties of ZnO Nanotubes from Electrospun Fiber Templates.” Frederick Ochanda, Dickson Andala, Kevin Cho, Thomas Keane, Wayne E. Jones, Jr., *Langmuir*, 2009, 25(13), 7547-7552.

“New Synthesized Structure of Trans-dichlorobis (1,3-diaminopropane)₂ Ruthenium (III) Chloride.” Peter N. Kariuki, Shailesh Upreti, Christopher M. Madl, and Wayne E. Jones, Jr., *Acta Cryst. C*, 2009 submitted.

“Spectroscopic and ab initio Study of an Intramolecular Charge Transfer (ICT) Rhodanine Derivative.” Jayanta Ray, Nabamita Panja, Prasanta K. Nandi, Justin J. Martin, Wayne E. Jones, Jr., *J. Molecular Structure*, 2008, 874, 121-127.

“Fabrication and Thermal analysis for submicron Silver tubes prepared by Electrospun Fiber Templates.” Frederick Ochanda, Wayne E. Jones, Jr., *Langmuir*, 2007, 23 (2): 795-801.

“Enhanced Conductivity of Thin Film Polyaniline by Self-Assembled Transition Metal Complexes,” David Sarno, Justin Martin, Steve Hira, Clifford Timpson, Wayne E. Jones, Jr., *Langmuir*, 2007, *Langmuir*, 23 (2), 879-884.

“A Numerical Study of Transport in a Thermal Interface Material Enhanced with Carbon Nanotubes,” Anand Desai, Satish Mahajan, Ganesh Subbarayan, Wayne E. Jones Jr., James Geer, Bahgat Sammakia, *J. Electronics Packaging*, 2006, 128(1), 92-97.

“Fabrication and Thermal analysis for submicron Silver tubes prepared by Electrospun Fiber Templates.” Frederick Ochanda, Wayne E. Jones, Jr., *Langmuir*, 2007, *LANGMUIR* 23 (2): 795-801.

“Hybrid Metal Organic Polymer Complexes as Fluorescence Turn-on Sensors for Iron,” Lijuan Fan, Wayne E. Jones, Jr., *J. Am. Chem. Soc.*, 2006, 128(21), 6784-6785.

“Synthesis and Assembly of Metal Nanoparticles on Electrospun Poly(4-vinylpyridine) Fibers and Poly(4-vinylpyridine) Composite Fibers,” Hong Dong, Ed Fey, Anna Gandelman, Wayne E. Jones, Jr., *Chem. Materials*, 2006, 18, 2008-2011.

“Hemilabile Coordination Complexes for Sensing Applications,” Sarah E. Angell, Cerrie W. Rogers, Yan Zhang, Michael O. Wolf, Wayne E. Jones Jr., *Coord. Chem. Rev.*, 2006, 250, 1829-1841.

“Studies of Photoinduced Electron Transfer (PET) and Energy Migration in a Conjugated Polymer System for Fluorescence "Turn-on" Chemosensor Applications,” Lijuan Fan, Wayne E. Jones, Jr., *J. Phys. Chem.*, 2006, 110(15), 7777-7782.

ALISTAIR J. LEES (S2 815, x72362)

Professor

Inorganic Chemistry

Dr. Lees received his B.Sc. (Honors) and Ph.D. degrees from the University of Newcastle-upon-Tyne. He did postdoctoral research with Professor Arthur Adamson at the University of Southern California, and joined the faculty at SUNY-Binghamton in 1981. He was Visiting Professor at the University of Cambridge with Professor Lord Jack Lewis in 1989 and was Professor and Dean of Science at the University of Central Lancashire in 1992-94 and Visiting Professor at the University of York with Professor Robin Perutz in 1997.

RESEARCH INTERESTS

Our research interests are in organometallic photochemistry with a current emphasis on transition-metal photophysics, photochemical mechanisms, photoinitiation and photocatalytic processes in thin film materials and organometallic complexes as spectroscopic probes and sensors. Recent work (funded by the Department of Energy) has included measuring the first available quantitative photochemical data for a number of important intermolecular Si-H and C-H bond activation processes, determining the photochemistry of metal cluster complexes that present new avenues for activation and catalysis, a photochemical investigation of the distinct singlet and triplet excited-state reactivities of $W(CO)_4(en)$ ($en = ethylenediamine$), characterization of the luminescent complex, $W(CO)_4(4-Me-phen)$ ($phen = 1,10-phenanthroline$), in room-temperature and low-temperature glassy solutions and in acrylate thin films and demonstrating its usefulness as a spectroscopic probe, exploring the long-wavelength photochemistry of $CpFe(CO)_2I$ and facilitating an improved synthetic pathways to azaferrocene, and an investigation of the wavelength-dependence photochemistry of $[CpFe(arene)]X$ ($arene = benzene, toluene, naphthalene, pyrene$; $X = PF_6, BF_4, SbF_6, AsF_6, CF_3SO_3$), a well-recognized photocatalyst/photoinitiator in thin films. Furthermore, we have recently begun to investigate a number of molecular squares and other configurations involving organometallic species as potential sensors.

TYPES OF RESEARCH EXPERIENCE AVAILABLE

Synthesis and/or physical study (spectroscopy/ photochemistry) of organometallic complexes. Students will have an opportunity to learn FT-IR, UV-vis, fluorescence and photochemical techniques in the research laboratory.

SPECIFIC PREREQUISITES

Courses: Introductory Chemistry (107 and 108 or 111) and Analytical Chemistry (221) are recommended.

PERSONAL

Students must be highly motivated and willing to devote at least 12-15 hours/week to the research.

RELEVANT PUBLICATIONS

"Quantitative Wavelength Dependent Photochemistry of the $[CpFe(\eta^6-ipb)]PF_6$ ($ipb = isopropylbenzene$) Photoinitiator," Vladimír Jakúbek and Alistair J. Lees, *Inorg. Chem.* **2000**, 39, 5779-5786.

"Quantitative Photochemistry of Organometallic Complexes: Insight to their Photophysical and Photoreactivity Mechanisms," Alistair J. Lees, *Coord. Chem. Revs.* **2001**, 211, 255-278.

"One-Step Self-Assembly Organometallic Molecular Cages from 11 Components," Shih-Sheng Sun and Alistair J. Lees, *Chem. Commun.*, **2001**, 103-104.

"Luminescent Metal Complexes as Spectroscopic Probes of Monomer/Polymer Environments," Alistair J. Lees, in *Sensors and Optical Switching Phenomena*, V. Ramamurthy and Kirk S. Schanze, Eds.,

Molecular and Supramolecular Photochemistry Series, Vol. 7, Marcel Dekker, New York, **2001**, Chapter 5, 209-255.

"Photophysics and Evidence of Excimer Formation, Linear Bipyridines in Solution and Solid Films," Shih-Sheng Sun and Alistair J. Lees, *J. Photochem. Photobiol. A: Chem.*, **2001**, *140*, 157-161.

"Acetonitriletricarboxyl(2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline)rhenium(I) hexafluorophosphate," Shih-Sheng Sun, Peter Y. Zavalij, and Alistair J. Lees, *Acta Cryst.*, **2001**, *E57*, m119-m121.

"Self-Assembly Organometallic Squares with Terpyridyl Metal Complexes as Bridging Ligands," Shih-Sheng Sun and Alistair J. Lees, *Inorg. Chem.*, **2001**, *40*, 3154-3160.

"Synthesis and Photophysical Properties of Dinuclear Organometallic Rhenium(I) Diimine Complexes Linked by Pyridine-Containing Macrocyclic Phenylacetylene Ligands," Shih-Sheng Sun and Alistair J. Lees, *Organometallics*, **2001**, *20*, 2353-2358.

"Synthesis, Photophysical Properties and Photoinduced Luminescence Switching of Trinuclear Diimine Rhenium(I) Tricarbonyl Complexes Linked by an Isomerizable Stilbene-Like Ligand," Shih-Sheng Sun and Alistair J. Lees, *Organometallics*, **2002**, *21*, 39-49.

"Photophysical and Photochemical Properties of W(0) and Re(I) Carbonyl Complexes Incorporating Ferrocenyl-Substituted Pyridine Ligands," Shih-Sheng Sun, Dat T. Tran, Onduru S. Odongo, and Alistair J. Lees, *Inorg. Chem.*, **2002**, *41*, 132-135.

"Synthesis and Electrochemical, Photophysical and Anion Binding Properties of Self-Assembly Heterometallic Cyclophanes," Shih-Sheng Sun, Jason A. Anspach, Alistair J. Lees, and Peter Y. Zavalij, *Organometallics*, **2002**, *21*, 685-693. 109.

"Transition Metal Based Supramolecular Systems: Synthesis, Photophysics, Photochemistry and their Potential Applications as Luminescent Anion Chemosensors," Shih-Sheng Sun and Alistair J. Lees, *Coord. Chem. Revs.*, **2002**, *230*, 162-183.

"Self-Assembly Transition Metal Based Macrocycles Linked by Photoisomerizable Ligands: Examples of Photoinduced Conversion of Tetranuclear-Dinuclear Squares," Shih-Sheng Sun, Jason Anspach, and Alistair J. Lees, *Inorg. Chem.*, **2002**, *41*, 1862-1869.

"Multi-Emission Photochemistry," Alistair J. Lees and Shih-Sheng Sun, In *Comprehensive Coordination Chemistry II: From Biology to Nanotechnology*, J.A. McCleverty and T. J. Meyer, Editors, Pergamon, Oxford, 2003, Chapter 1.113, in press.

"Highly Sensitive Luminescent Metal-Complex Receptors for Anions through Charge-Assisted Amide hydrogen Bonding," Shih-Sheng Sun, Alistair J. Lees and Peter Y. Zavalij, *Inorg. Chem.*, 2003, *42*, 3445-3453.

ZHITAO LI (S2 332, x74825)

Assistant Professor

Organic Chemistry

Dr. Li received his B.S. in Chemistry from Fudan University (Shanghai, China) in 1996, M.S. in Organic Chemistry from Peking University (Beijing, China) in 1999 and Ph.D. in Organic Chemistry from Duke University (Durham, North Carolina) in 2003. He did postdoctoral research in tumor antigen related oligosaccharide synthesis and development of carbohydrate array at the National Cancer Institute at Frederick. He joined the faculty at SUNY-Binghamton in 2006.

RESEARCH INTERESTS

My research interest is in the field of carbohydrate natural product chemistry. One project is the total synthesis and combinatorial synthesis of anthocyanin natural products. Anthocyanin is a class of natural product with very interesting biological activities. A novel total synthesis will be developed and a natural product library will be synthesized through combinatorial chemistry. The natural product library will be studied for cancer chemoprevention properties and anti-diabetic activities. Another project will involve the development of new glycosylation methodologies. Carbohydrate plays a very important role in biological processes, like cell adhesion, cell recognition, protein folding and inflammation. Study of glycobiology requires homogeneous and structurally well-defined oligosaccharides, which can only be obtained in large quantity through chemical synthesis. However, oligosaccharide synthesis requires highly controlled regio- and stereoselectivity and is a much more challenging task compared to the syntheses of other biopolymers, like peptides and oligonucleotides. This project will focus on development of new glycosylation strategies with better regioselectivity and overall efficiency. Computational chemistry is used to estimate reactivity and understand reaction pathway.

TYPES OF RESEARCH EXPERIENCE AVAILABLE

Total synthesis and biological study of natural products, development of new synthetic methodology. Students will have an opportunity to learn organic synthesis, chromatography, and spectroscopic (NMR, fluorescence and UV/vis) techniques in the research laboratory.

PERSONAL

Students must have taken organic chemistry (I and II) and organic lab (at least I) to be considered. Students must also be highly motivated and willing to devote at least 12-15 hours/week to the research.

RELEVANT PUBLICATIONS

Li, Zhiao; Ngojeh, George; DeWitt, Paul; Zheng, Zhi; Chen, Min; Li, Vincent; Lainhart, Brendan; Felpo, Peter. "Synthesis of a Library of Glycosylated Flavonols". *Tetrahedron Lett* **2008**, 48, 7243-7245.

Lin, Bo; Li, Zhitao; Park, Kaapjoo; Deng, Liu; Pai, Ashok; Zhong, Ling; Pirrung, Michael C. and Webster, Nicholas J.G. "Identification of novel orally-available small molecule insulin mimetics" *Journal of Pharmacology and Experimental Therapeutics*, **2007**, 323(2), 579-585.

Manimala, Joseph C.; Roach, Timothy A.; Li, Zhitao; and Gildersleeve, Jeffrey C. "High-Throughput Carbohydrate Microarray Profiling of 27 Antibodies Demonstrates Widespread Specificity Problems". *Glycobiology*, **2007**, 17(8), 17C-23C.

Pirrung, Michael C.; Li, Zhitao; Hensley, Erika; Liu, Yufa; Tanksale, Aparna; Lin, Bo; Pai, Ashok; Webster, Nicholas J. G. "Parallel Synthesis of Indolylquinones and Their Cell -based Insulin Mimicry". *J. Comb. Chem.* **2007**, 9(5), 844-854.

Lin Bo; Pirrung Michael C; Deng Liu; Li Zhitao; Liu Yufa; Webster Nicholas J G "Neuroprotection by small molecule activators of the nerve growth factor receptor". *The Journal of pharmacology and experimental therapeutics* **2007**, 322(1), 59-69.

Li, Zhitao; Gildersleeve, Jeffrey C. "An armed-disarmed approach for blocking aglycon transfer of thioglycosides". *Tetrahedron Lett.* **2007**, 48(4), 559-562.

Li, Zhitao; Gildersleeve, Jeffrey C. "Mechanistic Studies and Methods to Prevent Aglycon Transfer of Thioglycosides" *J. Amer. Chem. Soc.* **2006**, 128, 11612-11619.

Manimala, Joseph C.; Roach, Timothy A.; Li, Zhitao; Gildersleeve, Jeffrey C. "High-Throughput Carbohydrate Microarray Analysis of 24 Lectins". *Angew Chem Int Ed Engl.* **2006**, 45, 3607-3610.

Pirrung, Michael C.; Li, Zhitao; and Liu, Hao. "Synthetic Libraries of Fungal Natural Products," in "Combinatorial Synthesis of Natural Product Based Libraries," Boldi., A. M., Ed., CRC Press, NY, **2006**.

Manimala, Joseph; Li, Zhitao; Jain, Amit; VedBrat, Sharanjeet; and Gildersleeve, Jeffrey C. "Carbohydrate Array Analysis of Anti-Tn Antibodies and Lectins Reveals Unexpected Specificities: Implications for Diagnostic and Vaccine Development" *ChemBioChem*, **2005**, 6, 2229-2241.

Pirrung, Michael C.; Liu, Yufa; Deng, Liu; Halstead, Diana K.; Li, Zhitao; May, John F.; Wedel, Michael; Austin, Darrell A.; Webster, Nicholas J. G. "Methyl Scanning: Total Synthesis of Demethylasterriquinone B1 and Derivatives for Identification of Sites of Interaction with and Isolation of Its Receptor(s)" *J. Amer. Chem. Soc.* **2005**, 127, 4609-4624.

Sohn, Jungsan; Kiburz, Brendan; Li, Zhitao; Deng, Liu; Safi, Alexias; Pirrung, Michael C.; Rudolph, Johannes. "Inhibition of Cdc25 Phosphatases by Indolyldihydroxyquinones," *J. Med. Chem.*, **2003**, 46, 2580-2588.

Pirrung, Michael C.; Deng, Liu; Li, Zhitao; Park, Kaapjoo. "Synthesis of 2,5-Dihydroxy-3-(indol-3-yl)benzoquinones by Acid-Catalyzed Condensation of Indoles with 2,5-Dichlorobenzoquinone," *J. Org. Chem.*, **2002**, 67, 8374-8388.

Pirrung, Michael C.; Li, Zhitao; Park, Kaapjoo; Zhu, Jin. "Total Syntheses of Demethylasterriquinone B1, an Orally Active Insulin Mimetic, and Demethylasterriquinone A1," *J. Org. Chem.*, **2002**, 67, 7919-7926.

Pirrung, Michael C.; Park, Kaapjoo; Li, Zhitao. "Synthesis of 3-indolyl-2,5-dihydroxybenzoquinones," *Org. Lett.*, **2001**, 3, 365-367.

Wang, Shu; Li, Zhitao; Hua, Wenting. "Synthesis and characterization of fully conjugated schiff base macrocycles containing 1,3,4-oxadiazole moiety," *Synth. Comm.*, **2002**, 32, 3339-3345.

ERIKS ROZNERIS (S2 229, x72441)

Associated Professor

Organic and Bioorganic Chemistry

Dr. Rozners received his B.S. and Ph.D. degrees from Riga Technical University (Latvia) in 1990 and 1993, respectively. He was a Postdoctoral Fellow with Prof. Roger Stromberg at Stockholm University and Karolinska Institute (Sweden) from 1994 to 1997 and with Prof. Edwin Vedejs at University of Wisconsin Madison and University of Michigan from 1997 to 2000. Before joining Binghamton University in 2008, Dr. Rozners was Assistant Professor at Northeastern University in Boston.

RESEARCH INTERESTS

Prof. Rozners' research interests are in the chemistry and biochemistry of nucleic acids with a focus on elucidation of RNA's structure and function. The research philosophy is to use organic chemistry as the enabling discipline to create unique model systems and tools for fundamental studies and practical applications in nucleic acid biochemistry, biophysics and biomedicine. The current projects include design, synthesis, and biophysical exploration of RNA analogs having non-phosphorous internucleoside linkages and development of novel RNA binders for biomedical applications. Amide-linked RNA has the structural features of both nucleic acids and proteins and is of particular interest as an intriguing model system to study biopolymer recognition and for design of artificial enzymes and therapeutic agents. Other interesting modifications are RNA analogues having formacetal internucleoside linkages. Modified RNAs have therapeutic potential in antisense, antigene and RNA interference applications. More efficient routes to make highly modified nucleic acid analogs are being sought to make them more readily available for further evaluation.

Prof. Rozners' research is interdisciplinary in nature, involving exploratory studies on synthetic organic methodology including combinatorial chemistry, catalytic enantioselective Nozaki-Hiyama-Kishi reaction, total synthesis of natural products and their analogues (e.g., modified RNA and peptides), and the study of biochemical and biophysical properties of the synthesized analogues. Methods such as UV thermal denaturation, fluorescence spectroscopy and osmotic stress are used to characterize modified oligonucleotides.

SELECTED PUBLICATIONS

Li, F.; Pallan, P.; Maier, M.; Rajeev, K.; Mathieu, S.; Kreutz, C.; Fan, Y.; Sanghvi, J.; Micura, R.; Rozners, E.; Manoharan, M.; Egli, M. Crystal structure, stability and in vitro RNAi activity of oligoribonucleotides containing the ribo-difluorotoluy nucleotide: insights into substrate requirements by the human RISC Ago2 enzyme *Nucleic Acids Res.*, **2007**, *35*, 6424-6438.

Donahue, C. P.; Ni, J.; Rozners, E.; Glicksman, M.; Wolfe, M. S. Identification of Tau Stem Loop RNA Stabilizers. *J. Biomolecular Screening*, **2007**, *12*, 789 - 799.

Rozners, E.; Katkevica, D.; Stromberg, R. Oligoribonucleotide Analogues Having a Mixed Backbone of Phosphodiester and Formacetal Internucleoside Linkages with Vicinal 2'-O-Methyl Groups. *ChemBioChem* **2007**, *8*, 537-545.

Xu, Q.; Katkevica, D.; Rozners, E. Toward Amide Modified RNA: Synthesis of 3'-Aminomethyl-5'-Carboxy-3',5'-Dideoxy Nucleosides. *J. Org. Chem.* **2006**, *71*, 5906-5913.

Rozners, E.; Smicius R.; Uchiyama, C. Expanding Functionality of RNA: Synthesis and Properties of RNA Containing Imidazole Modified Tandem G-U Wobble Base Pairs. *Chem. Commun.* **2005**, 5778-5780.

Rozners, E.; Liu, Y. Monomers for Preparation of Amide Linked RNA: Asymmetric Synthesis of All Four Nucleoside 5'-Azido 3'-Carboxylic Acids. *J. Org. Chem.* **2005**, *70*, 9841-9848.

Xu, Q.; Rozners, E. Asymmetric Synthesis of *trans*-3,4-Dialkyl-g-butyrolactones via an Acyl-Claisen and Iodolactonization Route. *Org. Lett.* **2005**, *7*, 2821-2824.

Rozners, E.; Moulder, J. Hydration of Short DNA, RNA, and 2'-OMe Oligonucleotides Determined By Osmotic Stressing. *Nucleic Acids Res.* **2004**, *32*, 248-254.

Rozners, E.; Xu, Q. Total Synthesis of 3',5'-C Branched Nucleosides. *Org. Lett.* **2003**, *5*, 3999-4001.

Rozners, E.; Katkevica, D.; Bizdena, E.; Stromberg, R. Synthesis and Properties of RNA Analogs Having Amides as Interuridine Linkages at Selected Positions *J. Am. Chem. Soc.* **2003**, *125*, 12125-12136.

Rozners, E.; Liu, Y. Toward Amide Linked RNA Mimics: Total Synthesis of 3'-C Branched Uridine Azido Acid via an Ene-Iodolactonization Approach. *Org. Lett.* **2003**, *5*, 181-184.

WUNMI SADIK (S2 708, x7-4132)

Professor

Bioanalytical, Environmental and Materials Chemistry

Dr. Sadik received her Ph.D. in Chemistry from the University of Wollongong in Australia and did her postdoctoral research at the US Environmental Protection Agency (US-EPA) in Las Vegas, Nevada. Dr. Sadik has held appointments at Harvard University, Cornell University and Naval Research Laboratories in Washington, DC. Sadik's research currently centers on the interfacial molecular recognition processes, sensors and biomaterials, and immunochemistry with tandem instrumental techniques. Her work utilizes electrochemical and spectroscopic techniques to study human exposure assessment, endocrine disrupters, and toxicity of engineered nanomaterials and naturally occurring chemical compounds.

Sadik is the recipient of NSF Discovery Corps Senior Fellowship 2005, Distinguished Radcliffe fellowship at Harvard University 2003, outstanding inventor 2002, Chancellor award for research 2001, and NRC Cobase fellow, 2000.

RESEARCH INTERESTS (For additional information please visit our group website: <http://www.chem.binghamton.edu/SADIK/sadik.htm>)

Our research is focused on the basic and applied aspects of bioanalytical, materials and environmental chemistry. We are interested in the design and development of chemical and biological sensors that are inspired by the recognition processes found in nature. Perhaps the best and most sophisticated recognition process is found in the human body. For example, our senses of smell, tastes and ability to respond to temperature variation all occur via living polymer interfaces. Even cellular processes are regulated by cell walls, comprising dynamic macromolecules that are capable of sensing and responding to specific chemical stimuli. Hence, by learning from nature, we are developing smart sensors that can be used for applications in environmental monitoring, homeland security, process control and biomedical testing. Selected projects are discussed below.

CHEMICAL BIOSENSORS

The design of biosensors requires the successful immobilization of biological reagents such as antigen, antibody, enzymes, DNA or cells. A number of approaches for immobilizing antibody and dsDNA layers on electrodes have been reported, yet the quest for a molecularly organized, but reproducible immobilization continues to pose a challenge. A major research question is how to design the interface between the transducer and the biospecific layer for efficient molecular recognition. Basic questions include the exact nature of the intermolecular forces at the sensor/biospecific layer and sensor/analyte interfaces, and also whether these forces are responsible for the partial discrimination between different chemical and biochemical compounds. Understanding, engineering and predicting the interactions between molecules require the knowledge of the available types of interactions and a rational design of the sensor chemistries.

ENVIRONMENTAL CHEMISTRY

In the area of environmental chemistry, we are focused on understanding the mechanisms by which natural and synthetic toxins interact with complex environmental matrices and the biological system. We are also currently funded by the US-EPA under the STAR program to design new nanomaterials for environmental detection and remediation. We have developed new

materials for selective removal of certain metals and organics and tested these materials for catalytic conversion of high-valent heavy metals into their low oxidation state equivalents. Research opportunities exist to explore the use nanostructured materials for the rapid conversion of Cr (VI) to Cr(III), design/testing of nanoreactors for environmental monitoring including the understanding of the fate, transport, and transformation of emerging contaminants with cells and complex matrices.

RECENT PUBLICATIONS

1. Sadik O. A., Zhou Ailing, Aluoch A., Status of Biomolecular Recognition using Electrochemical Techniques – *Biosensors & Bioelectronics*, 24, 2749-2765, **2009**.
2. Sadik O. A., JEM Spotlight: Applications of advanced nanomaterials for environmental monitoring Foreword, *Journal of Environmental Monitoring*, 11, 25-26, **2009**.
3. Omole M. A., Kowino I. Sadik O. A., Nanostructured Materials for Improving Water Quality: Potentials & Risks, In *Nanotechnology Applications: Solutions for Improving Water Quality*, Street A., Duncan J., Mamadou D., Savage N. Sustich R., Editors, EPA Handbook on Nanotechnology, **2009**.
4. Zhou A. Sadik O. A., Comparative analysis of quercetin oxidation by electrochemical, Enzymatic, Air oxidation, enzymatic and free-radical oxidation: A mechanistic study, *Journal of Agricultural & Food Chemistry*, **2008**, 56(24), 12081–12091.
5. Fatah A., Arcilesi R., Chekol T., Chalotte Latin, Sadik O. A., Aluoch A., Guide for the Selection of Biological Agent Detection Equipment for Emergency First Responders, Second Edition, Guide 101-104, March **2007**, US Department of Homeland Security, Preparedness Directorate, Office of Grants and Training Systems Support Division, Washington DC.
6. Vicki A. Grassian, Gerald Meyer, Hector Abruna, Sadik O. A., Chemistry for a Sustainable Future, *Environmental Science & Technology*, July 15, page 4840-4846, **2007**.
7. Zhou, S. Kikandi, O. A. Sadik, “Electrochemical Degradation of Quercetin: Isolation and Structural Elucidation of the Degradation Products”, *Electrochemistry Communications* 9, 2247–2256, **2007**.
8. Sadik O., Juan Brito, Kikandi S., “Electroless Deposition of Titanium onto Aluminum Substrates,” *Journal of Electrochemical Society*, 154(7) D346, (**2007**).
9. Jason Karasinski, Silvana Andreescu, Leslie White, Yachao Zhang and Omowunmi A. Sadik, Barry K. Lavine and Mehul Vora, Detection and Identification of Bacteria using Antibiotic Susceptibility and a Multiarray Electrochemical Sensor with Pattern Recognition, *Biosensors & Bioelectronics*, 22(**2007**) 2646-2649.
10. Marcellus A. Omole, Isaac O. K’Owino & Omowunmi A. Sadik, Palladium Nanoparticles for Catalytic Reduction of Cr (VI) using Formic Acid, *Applied Catalysis B Environmental*, 76, 158-176, **2007**.
11. Silvana Andreescu, Jason Karasinski, Omowunmi A. Sadik, Multiarray Biosensors for Toxicity Monitoring and Bacterial Pathogens, In: *Smart Biosensors*, Knopf G. K., Bassi A. S. Editors, CRC Press, USA, pp 521-538, **2007**.
12. Andreescu S. Karasinski J., Sadik O.A., High-throughput Biosensor Systems for Monitoring Cells and Bacteria, *Encyclopedia of Sensors*, Edited by Graig A. Grimes, Elizabeth C. Dickey, Michael V. Pishko, Volume 4, pages 459-480, **2006**, American Scientific Publishers.
13. Andreescu, D., Wanekaya A., O.A. Sadik, Wang J., “Nanostructured Polyamic Membranes as Electrode Material,” *Langmuir*, 21(15), 6891-6899, **2005**.

MICHAEL E. STARZAK (S2 129, X72089)

Professor

Physical Chemistry

Dr. Starzak earned an Sc.B. from Brown University and a Ph.D. from Northwestern University. He has served on the faculties of the University of California, Santa Cruz and the University of California, Berkeley before coming to the State University of New York at Binghamton. Dr. Starzak has received a Chancellor's Award for Excellence in Teaching and a Fulbright Fellowship for teaching and research in Poland. He is the author of three books, **The Physical Chemistry of Membranes**, **Mathematical Methods in Chemistry and Physics**, and **Introductory Physical Chemistry** (In press).

RESEARCH INTERESTS

I develop new kinds of laser spectroscopy and electrochemistry instrumentation to study the kinetics and binding of ions to variety of molecular systems including proteins and membrane soluble ion complexes. The relevant instrumentation, which has been conceived, designed and used in my laboratory includes:

1. Environment-sensitive laser emission spectroscopy using Eu(III) ion as a probe.

This spectroscopic technique takes advantage of the narrow absorption linewidth (0.05nm) of Eu(III) ion to study the microscopic environments of the ion. For example, Eu(III) in bulk aqueous solution absorbs light of 579.0nm while Eu(III) bound to poly-L-glutamic acid absorbs at 579.15nm. A narrowband dye laser (0.01nm) lets us selectively excite ions bound to the protein site. The magnitude of the shift, the emission lifetime of the ion, the splitting of the spectra in the local ligand field and the energy transfer to an acceptor ion at a different site permit us to determine the binding energy, residual inner shell waters, local binding site symmetry and site-site distances, respectively. These data permit a thorough characterization of the ion binding site. Projects with this instrument range from fundamental kinetics (the mobility of the inner sphere waters and counterions) to health-related studies (the structural changes that produce increased fluid viscosity in cystic fibrosis patients).

2. Laser Doppler Spectroscopy

Laser light scattering from a moving particle produces a Doppler shift of the laser light that can be measured to determine the velocity of the particle. Our laser Doppler system is designed to detect the motions of membrane-soluble ions and ions in transmembrane channels in bilayer membranes. Such experiments require development of novel electronic systems for detection of samples at very low concentrations. For example, the technique has been used to monitor the velocities of the 10^7 Tl(I) ions that cross a gramicidin channel each second.

3. Scattering Intensity Enhancement of Membrane-soluble Ions in Membranes.

A highly polar ion can be dissolved in a non-polar membrane by encasing it in an ionophore molecule to screen the ion charge. Scattering from this ion increases dramatically in this conformation. I have developed instrumentation to probe this phenomenon.

4. Electrochemistry of Ions as Ion/ionophore Complexes and as Permeant Ions in Membrane Channels.

Special potential ramp techniques are used to study the anomalous mole fraction effect in which Tl(I) ion in gramicidin channels acts as both a permeant ion and a blocking ion depending on bathing condition solutions. The study involves both experimental measurements and development and testing of a new model to successfully explain this rather novel behavior.

5. A Microscopic Laser

I am presently developing a brand new type of laser that will produce a beam of extremely small diameter that can be used as a structure probe.

6. Kinetic Modeling

The experiments described above are often accompanied with a concurrent theoretical development of new kinetic models. The special kinetics for the anomalous mole fraction effect is one example. A second model predicts the kinetics of membrane-soluble ions using a model based on the viscosity generated as this large ion displaces the long molecules that constitute the membrane.

Independent research in my laboratory does require a willingness to learn both the relevant physical and biophysical chemistry and the electronics and optics necessary to understand the instrumentation. Students who have had some physical chemistry with me can move to "independent" research more rapidly. However, if you are interested in this kind of research, I would enjoy talking with you. For example, one sophomore student learned both electronics and optics "on the job", redesigned the Eu(III) laser spectrometer and generated much of the data that led to the poly-L-glutamic acid paper. That's the kind of experience that makes independent research exciting.

RELEVANT EXPERIMENTAL PUBLICATIONS

Argiros, A. and Starzak, M. Carrier-mediated transport in model membranes monitored by Eu³⁺ emission J. Lumin.(In Press)

Grygiel, W. and Starzak, M. Kinetic and Symmetry Studies of the Inner Hydration Sphere of Eu³⁺ ion using environment sensitive laser excitation spectroscopy J. Lumin. 71, 21 (1997)

Starzak, M. Illustrating chemical principles by ion motions in thin membranes. J. Chem. Ed. 74, 410 (1997)

Starzak, M. Membranes (Synthetic) In: Academic Press Encyclopedia of Physical Science and Technology (new edition - 2000)

Macias, F. and Starzak, M. Ion velocity distributions in gramicidin channels determined with laser Doppler velocimetry. Biochim. Biophys. Acta 1153, 331 (1994)

EUGENE S. STEVENS (S2 128, x74244)

Professor

Physical Chemistry

Eugene Stevens received his B.S. in chemistry from Yale University in 1960 and his Ph.D. from the University of Chicago in 1965. He was an NSF postdoctoral fellow at Harvard University in 1965-66. He has been at Binghamton since 1977.

RESEARCH INTERESTS

We have recently turned our attention to the use of biopolymers for the production of biodegradable plastics. Polysaccharides (e.g., starch, cellulose, agar) are abundant renewable biomass polymers, and their use for the production of degradable, biodegradable, and compostable materials conserves nonrenewable fossil resources. It also diverts waste plastics from incinerators and landfills. See my website at greenplastics.com.

SELECTED PUBLICATIONS

"Green Plastics. An Introduction to the New Science of Biodegradable Plastics," E.S. Stevens, Princeton University Press, Princeton, N.J. **2002**.

"How Green Are Green Plastics?," E. S. Stevens, *BioCycle*, December **2002**, 42-45.

"What Makes Green Plastics Green?," E. S. Stevens, *BioCycle*, March **2003**, 24-27.

"Environmentally Degradable Plastics," E. S. Stevens, *Encyclopedia of Polymer Science and Technology*, 3rd Edition, on-line version, March **2003**, print version, September **2003**.

"Tensile Strength Measurements on Biopolymer Films," E. S. Stevens and M. D. Poliks, *Journal of Chemical Education*, **2003**, *80*, 810-812.

"Polymer/Plastics Experiments for the Chemistry Curriculum," E. S. Stevens, K. Baumstein, J.-M. Leahy, and D. C. Doetschman, *Journal of Chemical Education*, **2006**, *83*, 1531-1533.

"Thermoplastic Starch-Kraft Lignin-Glycerol Blends," E. S. Stevens, J. L. Willett, R. L. Shogren, *Journal of Biobased Materials and Bioenergy*, **2007**, *1*, 351-359.

"Gelatin Plasticized with a Biodiesel Coproduct Stream," E. S. Stevens, R. S. Ashby, and D. K. Y. Solaiman, *Journal of Biobased Materials and Bioenergy*, **2009**, *3*, 57-61.

"Gelatin Films Plasticized with a Simulated Biodiesel Coproduct Stream," M. Singh, J. Milano, E. S. Stevens, R. D. Ashby, and D. K. Y. Solaiman, *eXPRESS Polymer Letters*, **2009**, *3*, 201-206.

M. STANLEY WHITTINGHAM (S2 120, x74623)

Professor

*Inorganic and Materials Chemistry, and Materials Science
& Engineering*

Dr. Whittingham received his B.A., M.A. and D.Phil. degrees in chemistry from Oxford University in England. He did postdoctoral research in materials at Stanford University in California, then worked at Exxon and Schlumberger in basic energy related research before joining the chemistry faculty at SUNY Binghamton in 1988. He is also the Director of the Institute for Materials Research here.

RESEARCH INTERESTS

The research interests of the Materials Chemistry group are in the preparation and chemical and physical properties of novel inorganic materials and all aspects of nanomaterials. Our long term goals are to solve the energy issues facing the United States.

The Nanochemistry of Materials is one of the two areas of chemistry experiencing the greatest growth at the present time both in academic institutions and industry. This popularity can be associated with the pervasiveness of solids throughout our lives from semiconductors through energy storage to geological/biological systems, and to a number of recent breakthroughs, including high temperature inorganic superconductors.

One aspect of our work is in finding new synthetic routes to prepare metastable compounds that cannot be prepared by traditional techniques. Primary emphasis is on reacting ions in solution often using large organic species as templates around which the inorganic solid forms. In some cases it is possible to form previously unknown open structures by diffusing ions out of existing structures creating vacant tunnels or layers in which chemistry may be performed or separations/catalysis carried out. These reactions can be followed using electrochemical, x-ray, gravimetric and standard chemical methods, among others.

A second aspect is the study of ionic motion in solids and its use in batteries and fuel cells. Here much emphasis is on the intercalation compounds of the transition metal oxides, and the research involves both high and low temperature chemistry. Of particular interest are the vanadium and manganese oxides, which can be prepared with a variety of layer structures and with tunnels. Different ions and molecules can be intercalated into these structures allowing the controlled modification of chemical and physical properties. In addition these intercalation reactions can be the basis for high energy density storage devices and have the potential for revolutionizing the field of nanoscience.

PREREQUISITES

An interest in chemistry and solids and a desire to go to graduate school.

RECENT PUBLICATIONS

1. Natasha A. Chernova, Miaomiao Ma, Jie Xiao, M. Stanley Whittingham, Julien Breger and Clare P. Grey "Layered $\text{Li}_x\text{Ni}_y\text{Mn}_z\text{Co}_{1-2y}\text{O}_2$ Cathodes for Lithium-Ion Batteries: Understanding Local Structure via Magnetic Properties", *Chem. Mater.*, 2007, 19: 4682-4693.
2. Jiajun Chen, Shijun Wang, M. Stanley Whittingham, The hydrothermal synthesis of cathode materials, *J. Power Sources*, 2007, 174: 442-448.
3. Quan Fan, Peter Chupas and M. Stanley Whittingham, "Characterization of Amorphous and Crystalline Tin-Cobalt Anodes". *Electrochem. Solid State Letters*, 2007, 10: A274-A278.

4. Jiajun Chen, Michael J. Vacchio, Shijun Wang, Natalya Chernova, Peter Y. Zavalij, M. Stanley Whittingham, "The hydrothermal synthesis and characterization of olivines and related compounds for electrochemical applications", *Solid State Ionics*, 2008, 178: 1676-1693.
5. M. Stanley Whittingham, "Materials Challenges Facing Electrical Energy Storage", *Mater. Res. Soc. Bulletin*, 2008, 33: 411-420.
6. Joel Christian and M. Stanley Whittingham, "Structural Study of Ammonium Metatungstate", *J. Solid State Chem.*, 2008, 181: 1782-1791.
7. Chunmei Ban and M. Stanley Whittingham, "Nanoscale single-crystal vanadium oxides with layered structure by electrospinning and hydrothermal methods", *Solid State Ionics*, 2008, 179: 1721-1724.
8. Megan Roppolo, Chris Jacobs, Shailesh Upreti, Natasha A. Chernova, and M. Stanley Whittingham, "Synthesis and characterization of layered and scrolled amine templated vanadium oxides", *J. Materials Science*, 2008, 43: 4742-4748.
9. M. Stanley Whittingham, "Inorganic nanomaterials for batteries", *Dalton Transactions*, 2008, 5424-5431.
10. Jie Xiao, Natasha A. Chernova, and M. Stanley Whittingham, "Layered Mixed Transition Metal Oxide Cathodes with Reduced Cobalt Content for Lithium Ion Batteries", *Chemistry of Materials*, 2008, 20: 7454-7464.
11. Jian Hong, C. S. Wang, X. Chen, S. Upreti, and M. Stanley Whittingham, "Vanadium Modified LiFePO_4 Cathode for Li-Ion Batteries", *Electrochem. Solid-State Letters*, 2009, 12: A33-A38.
12. Kazuo Eda, Yu Ohshiro, Noriko Nagai, Noriyuki Sotani, and M. Stanley Whittingham, "Transition metal tetramolybdate dihydrates $\text{MMo}_4\text{O}_{13}\cdot 2\text{H}_2\text{O}$ (M=Co,Ni) having a novel pillared layer structure", *J. Solid State Chem.*, 2009, 182: 55-59.
13. Chunmei Ban, Natalya Chernova, M. Stanley Whittingham, "Electrospun Nano-Vanadium Pentoxide Cathode", *Electrochem. Commun.*, 2009, 11: 522-525.
14. Natasha A. Chernova, Megan Roppolo, Anne Dillon and M. Stanley Whittingham, "Layered vanadium and molybdenum oxides: batteries and electrochromics", *J. Mater. Chem.*, 2009, 19: 2526-2552.
15. Anurag Mishra, Afsar Ali, Shailesh Upreti, M. Stanley Whittingham and Rajeev Gupta, "Cobalt complex as building blocks: Synthesis, characterization, and catalytic applications of $\{\text{Cd}^{2+}\text{-Co}^{3+}\text{-Cd}^{2+}\}$ and $\{\text{Hg}^{2+}\text{-Co}^{3+}\text{-Hg}^{2+}\}$ heterobimetallic complexes", *Inorganic Chemistry*, 2009, 48, 5234-5243.

CHUAN-JIAN ZHONG (S2 713, x74605)

Professor

Analytical Chemistry, Materials Chemistry, Catalysis, Electrochemistry, Nanotechnology

RESEARCH INTERESTS

Our research interests are in the interdisciplinary areas of materials, analytical, electrochemistry, catalysis, and emerging nanotechnology fields. The overall direction is the design, fabrication, characterization, and application of novel nanostructured materials and strategies for addressing challenging issues in chemical/biological sensors, catalysis, biomedical devices, and energy and environment. Our current research explores both fundamental and applied aspects in this general direction. The most recent projects explore molecularly-engineered nanomaterials with novel sensing, catalytic, optical, magnetic, and electronic functions, and probe the mechanistic details of chemistry and biochemistry at surfaces and interfaces.

One example of our approaches involves exploration of core-shell nanoparticles as building blocks towards functional nanostructures. The manipulation of size, shape, surface and interparticle spatial properties leads to novel chemical/biological functions, e.g., catalysts, sensors, and bio-probes for specific binding events of proteins, DNAs, and amino acids. The fundamental understanding of the interfacial phenomena and nanoscale chemistry at the molecular level has not only led us to the development of a number of important technologies in design and fabrication of nanoparticles and nanomaterials, but also the exploration of their industrial applications in microsensor technology, fuel cell technology and biomedical probes.

SELECTED PUBLICATIONS

L. Y. Wang, X. Shi, N. N. Kariuki, M. Schadt, G. R. Wang, Q. Rendeng, J. Choi, J. Luo, S. Lu, C. J. Zhong, "Array of Molecularly-Mediated Thin Film Assemblies of Nanoparticles: Correlation of Vapor Sensing with Interparticle Spatial Properties", *J. Am. Chem. Soc.*, **2007**, *129*, 2161-2170.

I-I. S. Lim, C. Vaiana, Z. Zhang, Y. Zhang, D. L. An, C. J. Zhong, "X-Shaped Rigid Arylethynes to Mediate the Assembly of Nanoparticles", *J. Am. Chem. Soc.*, **2007**, *129*, 5368-5369.

H. Y. Park, M. J. Schadt, L. Wang, I-Im S. Lim, P. N. Njoki, S. H. Kim, M.-Y. Jang, J. Luo, C. J. Zhong, "Fabrication of Magnetic Core@Shell Fe-Oxide@Au Nanoparticles for Interfacial Bioactivity and Bio-separation", *Langmuir*, **2007**, *23*, 9050 – 9056.

D. Mott, J. Galkowski, L. Wang, J. Luo, C. J. Zhong, "Synthesis of Size-Controlled and Shaped Copper Nanoparticles", *Langmuir*, **2007**, *23*, 5740-5745.

P. N. Njoki, S. I-Im Lim, D. Mott, H.-Y. Park, B. Khan, S. Mishra, R. Sujakumar, J. Luo, C. J. Zhong, "Size Correlation of Optical and Spectroscopic Properties for Gold Nanoparticles", *J. Phys. Chem., C*, **2007**, *111*, 14664-14669.

GUIDELINES FOR CHEMISTRY 397

Revised Spring 2003

CHEMISTRY 397, INDEPENDENT WORK

Variable Credit

Individual research under supervision of faculty member. Not limited to chemistry majors. Students must make formal application and receive approval of instructor and Department before the end of the drop/add period.

May be repeated for credit. No more than four credits of CHEM 397 may be used to satisfy major requirements for chemistry. Written report of work required.

NOTE: Chem 397 cannot be used to satisfy the organic, physical or analytical chemistry laboratory requirements for a chemistry major. Four credits of Chem 397 can be used to satisfy the Math-Science elective requirement for the BS degree and the chemistry elective for the BA degree.

Prerequisites: Consent of instructor and approval of the Undergraduate Program Committee Chair.

GUIDELINES

1. See restrictions in the catalog description above.
2. Enrollment in CHEM 397 for a maximum of 2 credits in the second half of any semester is permitted upon approval of an application submitted and approved prior to the established deadline for registration for "second-half" courses.
3. Credit for research not performed in the Chemistry Department requires written application and justification for study and sponsorship of a Chemistry faculty member who will assign the grade.
4. Stipend and credit for the same work will normally not be allowed.

GUIDELINES FOR CHEMISTRY 497

CHEMISTRY 497, ADVANCED INDEPENDENT WORK Variable Credit

Individual research under direct supervision of faculty member. Requires more extensive preparation than CHEM 397. Required for Honors Program in Chemistry.

[If you are considering Honors Program in Chemistry, you should examine the Guidelines early in your Junior year.]

Before advanced registration, student must make formal application and receive approval of instructor and department. May be repeated for credit. No more than twelve credits total of CHEM 397 and 497 may be used to satisfy major requirements for chemistry. Written report of work required.

Prerequisites: 1) Consent of instructor and approval of the UPC Chair; and 2) Demonstrated potential for independent study.

GUIDELINES:

1. See restrictions in the catalog description above.
2. Credit for research not performed in the Chemistry Department requires written application and justification from study and sponsorship of a Chemistry faculty member who will assign the grade.
3. Stipend and credit for the same work will normally not be allowed.
4. Average of "B" or better in the last twelve courses.
5. Junior standing.

NOTES:

1. Application must be made to the Independent Work and Honors Advisor of the Chemistry Department **no later than the end of the drop/add period.**
2. Application forms are available for the Chemistry Department Office (S2-236), and **must:**
 - a. list all chemistry and science division courses taken to date;
 - b. list the last twelve courses attempted and the grades received;
 - c. present a one to two page prospectus of the proposed project which includes background information, experimental methods, and appropriate literature references; and
 - d. include approval by the faculty member proposed to be the supervisor of the project.

GUIDELINES FOR CHEMISTRY 498

CHEMISTRY 498, ADVANCED INDEPENDENT WORK (HONORS)

Application and registration procedures are the same as for CHEM 397 and/or 497. In addition, the following guidelines have been established.

1. For admission, a student must meet the following criteria:
 - a. shall be entering his/her last semester and be an undergraduate major in chemistry;
 - b. shall have completed at least two credits of CHEM 497;
 - c. shall have been approved and registered for 4 credits of CHEM 498 during the last semester;
 - d. shall be recommended for the Honors Program by the faculty member who is supervising the research project.
 2. Application must be made to the Undergraduate Program Committee Chair no later than the first day of classes of the student's last semester.
 3. The application must include a prospectus of about five pages, complete with references, which will summarize work completed to date and will describe plans for completion of the project.
 4. To receive Honors, the candidate must successfully write and defend a thesis based on ~~his~~ his or her research. Successful defense is indicated by signatures of the defense committee on the signature page of your thesis.
 5. The thesis shall conform to the editorial standards for theses established by the Graduate School.
 6. Copies of the thesis must be submitted to the thesis advisor and members of the oral examination committee at least one week prior to the oral examination.
 7. The defense of the thesis shall be by an oral examination by a committee of no less than three faculty members approved by the Undergraduate Program Committee Chair and chaired by the faculty supervisor.
 8. Candidates whose theses are accepted and defended successfully will be awarded the honor "Distinguished Independent Work in Chemistry."
 - 4-9. A successful defense of your thesis is indicated by signatures of members of your defense committee on the signature page of your thesis. You must show the signature page, signed by your committee, to either Pat Gorman in the Department Office (Science 2, Room 226) or the Undergraduate Program Director.
 - 5- You need to submit the original and one copy of your thesis, in final form, to the Glenn G. Bartle Library, Acquisitions, for binding. One bound copy will be placed in the Library, and the other will be returned to the Chemistry Department. In addition please provide copies for any personal copies you wish to have bound. Personal copies will be bound for \$10.00 per copy.
- ~~You must show a cover page, signed by your committee, and the final copy of your thesis to either Pat Gorman in the Department Office (Science 2, Room 226) or the Undergraduate Program Director (Science 2, Room 308).~~

Formatted: Bullets and Numbering

Formatted: Bullets and Numbering

STATE UNIVERSITY OF NEW YORK AT BINGHAMTON - DEPARTMENT OF CHEMISTRY

Read attached guidelines; **print** everything, being sure to **fill in all appropriate blanks** as an incomplete application may not be approved; **submit** completed application directly to the Chemistry Department Secretary, S2-236.

CHEM 397 ___ or CHEM 497 ___ or CHEM 498 ___ for ___ credits for the ___ semester _____

NAME _____ BU # _____

CAMPUS ADDRESS _____ PHONE _____

EMAIL ADDRESS _____ YOUR MAJOR _____

For Chem 397, fill out Parts E and F. For Chem 497 and 498, fill out Parts A – F

A. List of semester of completion of the following courses

CHEM 111 (or 107-108) _____ Math 221 _____
CHEM 221 _____ Math 222 _____
CHEM 231 _____ Phys 121 _____ or 131 _____
CHEM 341 _____ Phys 122 _____ or 132 _____
CHEM 351 _____

B. List other courses in Chemistry and in the division of science and mathematics completed to date. Indicate with asterisk (*) those currently in progress.

C. List the last twelve courses completed, the semester of completion, and the grade received:

Course	Grade	Course	Grade	Course	Grade
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

D. Attach a 1-2 page (for Chem 497) or 4-5 page (for CHEM 498) prospectus, approved and signed by your proposed supervisor.

E. **Check** the subdivision of the proposed research:

___ **Q** Analytical Research ___ **T** Chem. Phys. Research ___ **W** Organic Research
___ **R** Bioorganic Research ___ **U** Inorganic Research ___ **Y** Physical Research
___ **S** Biophysical Research ___ **V** Materials Research ___ **Z** Phys Inorg Research

F. Student's Signature _____ Date: _____

Supervisor's Approval _____ Date: _____

Action of Chemistry Chair of the Undergraduate Program Committee: Approved for ___ hours or not approved ____.

Signature: _____ Date: _____

Comments:

