Mudd In Your Eye

Newsletter of the Department of Chemistry, Lehigh University

Number 39 • September 2010

"Great importance is given to chemistry as an elementary branch of learning." — Lehigh Register 1866

Moore Awarded NSF CAREER Grant

Assistant Professor David T. Moore has received a prestigious CAREER award from the National Science Foundation. This five-year award is designed to provide sustained funding for junior professors to see them through the tenure period. Moore, who joined the department in 2007, was successful on his first application although three are allowed. Moore's proposal, "Freeze-frame spectroscopy, a technique for elucidation of fundamental interactions underlying nanocatalytic reactions," was not based on his Ph.D. or post-doctoral work but is an original idea that he has developed since he's been at Lehigh.

"I've always been interested in fundamental science," Moore explains. "but as a young researcher looking for funding, I also realized that I would need my work to tie into an area of current interest. I found that there are many fundamental open issues concerning reaction mechanisms for catalytic reactions involving supported metal nanoparticles, and I thought I saw a new way to investigate them experimentally." While it is fairly straightforward to measure the activity of these nanocatalysts by looking at kinetic data or conversion efficiencies, getting direct information about the underlying reaction mechanisms is a more challenging problem. Moore's proposal involves the development of a new spectroscopic technique to directly probe the interactions of reactant molecules with nanocatalyst materials.

Back Row: Rebekah Klimas, Alex Hunter
Front Row: David Moore, Nina Finamore, Tony Thompson (undergraduate), Angela Smith

Moore chose the oxidation of carbon monoxide (CO) by molecular oxygen (O_2) over metal oxide-supported gold nanoparticles as his initial target system for the development of the freeze-frame spectroscopy method. Although gold is not generally considered to be chemically active in its bulk metallic form, in 1984 Haruta discovered that small gold nanoparticles on metal oxide supports were potent catalysts for this reaction at temperatures down to 173 K. "This seemed like an ideal place to start", says Moore, "because the literature contains conflicting theories and predictions about the nanocatalytic mechanism that remain unresolved. I thought that if we can find out precisely how gold acts to catalyze CO oxidation, then perhaps we could find ways to modify other less-expensive materials to do the same thing."

Moore also wanted to connect his research to alternate energy resources. The Department of Energy is funding research to develop hydrogen as an energy carrier that could be used in fuel-cells to provide heat and electricity for individual homes. One issue with such hydrogen fuel cells is that the platinum catalysts that are essential for their operation are extremely sensitive to poisoning by even small amounts of CO. Hydrogen is commercially made by steam reforming of hydrocarbons to generate syngas, which is mostly H_2 and CO. Most of the CO is then converted to more H_2 and CO_2 by the water gas shift reaction, but there is still more than can be tolerated if it is to come in contact with a Pt catalyst. The removal of the remaining CO is the target application for the gold nanoparticle catalysts Moore's group is studying.

Moore's hypothesis is that since the CO and O_2 must bind to the catalyst in some way, but the turnover must be rapid, so the binding of necessity cannot be very strong. He calls the binding of the CO and O_2 at a gold nanoparticle active site a "pre-reactive complex," a weakly-bound complex represented by a shallow well adjacent to a low activation barrier on the potential energy surface. These characteristics make such complexes ideal for understanding how the catalyst acts on the reactants to drive the creation and disruption of the chemical bonds required for product formation. "The issue," says Moore, "is that under normal reaction conditions there is plenty of energy available to drive these complexes over the barrier or make them fall apart, and thus they exist for only such short times and at such low concentrations as to make them undetectable experimentally. In my view, freeze-frame spectroscopy adds something that is fundamentally new in that we're actually going after the most weakly-bound species, which are likely to be the most catalytically relevant."

Moore's "freeze-frame" approach is based on using cryogenic matrix isolation techniques to trap the pre-reactive complexes at temperatures as low as 4 K, thus stopping the reaction progress at the desired point. Moore

then uses vibrational spectroscopy to get a "snapshot" of the structure of the complex, which then reveals how the reactant molecules change in response to the catalyst. "Molecules like CO and O_2 have characteristic vibrational frequencies that are quite sensitive to their chemical environments," explains Moore, "which makes them ideal probes for a structural study like this one."

Moore's experimental approach to freeze-frame spectroscopy has two distinct aspects: cryogenic spectroscopy of pre-reactive complexes on isolated, well-characterized model catalyst particles, and on "real" supported-nanocatalyst materials. The first aspect is to study the binding of CO and O_2 to unsupported gold nanoparticles in cryogenic matrices, and particularly to focus on how the interactions change with the size and charge of the nanoparticles. "This is a classic attempt to try to understand a complicated catalytic process in terms of a simplified model system where the parameters can be carefully controlled," says Moore. Gold nanoclusters of a particular charge and size, precisely known down to the exact number of atoms, are co-deposited with matrix gas (typically argon) on an IR-transmitting substrate cooled to about 10 K. Small concentrations of reactants (CO and/or O_2) are also present in the matrix gas. At 10 K, the argon matrix is quite rigid, so the nanoclusters and reactants are trapped in separate locations. However, warming the matrix to 25–30 K softens it, which allows the lighter reactant molecules to diffuse until they contact a gold nanoparticle, at which point Moore believes that the pre-reactive complexes that are the focus of this work will be formed. These conditions are designed to be "optimally gentle," to give the best chance of trapping the complexes before they can fall apart or react. The vibrational frequencies of the reactants are monitored throughout the process using FTIR spectroscopy, to observe the spectral changes that herald complex formation.

This general procedure will be repeated for positive, negative and neutral gold nanoclusters ranging in size from single atoms up to 50 or more, mapping out the infrared spectral trends over the series. These data will then be analyzed by comparison with calculated vibrational frequencies from density functional computations in order to assign structures and better understand the mechanistic aspects of the binding. "The computational chemists have been working on these model systems for quite some time now," Moore points out, "but for the most part they have been unencumbered by experimental data. Our data should be quite valuable for calibrating and vetting the computationally-derived models that have been proposed for the reaction mechanism." These theoretical studies typically predict the formation of pre-reactive complexes, which are often quite weakly bound, as the first step along the reaction pathway, but Moore's work would be the first to experimentally verify the existence of such species, and to provide information about their structures. Computational studies are part of Moore's research program as well, and he is getting ready to publish work on the structural, energetic and vibrational trends of CO and O_2 interacting with single gold atoms and ions.

The second aspect of Moore's research program is to use freeze-frame spectroscopy to look at CO and O_2 interacting with "real" metal oxide-supported gold nanoparticle catalysts. "One challenge faced by carefully controlled model studies like ours," explains Moore, "is that they seem somewhat disconnected from what goes on in the actual catalytic processes, where there are many more experimental variables and unknowns. However, we realized that we should be able to adapt freeze-frame spectroscopy to study a more typical nanocatalyst material."

For these studies, Moore takes a typical catalyst material such as gold nanoparticles supported on titania (TiO_2), and coats a thin film on an IR-transparent window. This window is then cooled to ~10 K, and an argon matrix containing the reactants is deposited over the top of it. The matrix is then annealed at 25–30 K, allowing the CO and O_2 to diffuse to the catalyst surface and form pre-reactive complexes, as in the experiments with free-nanoclusters. One important point is that these experiments will probe the role of the metal-oxide support material in the catalytic reaction, which is one of the many open mechanistic questions about CO oxidation on these catalysts.

Moore and his students have spent their first few years designing, building and testing the vacuum systems and cluster-ion sources that are required for his research. "It's been a long haul," says Moore, "but we are finally starting to get results." While the free-nanocluster source is still in the testing phase, Moore's student Becky Klimas has started to get results with the studies of real catalyst materials. She has demonstrated that the probe molecules do in fact diffuse and bind to the catalyst surface, an important proof-of-concept result, since such studies had not been previously published. Most recently, she has started to get data suggesting that the modes of binding for CO to the catalyst surface under cryogenic conditions are significantly different from what has been described in the literature at higher temperatures and pressures. "Our studies are particularly valuable because the experimental conditions are more similar to those assumed in the computational studies," explains Moore, "specifically very low concentrations and temperatures. It's still too early to say for sure, but it seems like CO may not bind to the gold nearly as strongly as suggested by some of the computational studies."

Moore grew up in the U.S. Virgin Islands. He claims "I've always been a person who watched, asked questions, and theorized about things." He has a B.S. in chemistry from Williams College and an M.S. in computational chemistry at UNC-Charlotte. His Ph.D. is from UNC-Chapel Hill, where he studied the vibrational spectroscopy of molecules in superfluid liquid helium nanodroplets. Two postdoctoral stints followed, the first to study vibrational spectroscopy of ionic clusters in the Netherlands, and the second at UC Berkeley.

Alumni News

Nickolas Agathis (B.A. 2010) has been accepted to the New York University medical school and will be attending there this fall..

Tara Blaney (M.S. 2000, Ph.D. University of Delaware) has relocated within Merck to a Clinical Scientist position in the Clinical Oncology group.

Jeff Gladding (B.S. 2004) finished his Ph.D. at the University of Pennsylvania with Professor Amos Smith and has moved to Boston, MA to start a post-doc with Professor Yoshito Kishi at Harvard University. In 2007 he married Steph Kravitz (Lehigh electrical engineering graduate, 2005).

Tracy L. L. Holbrook (M.S. 2008) is Lead Instructor in the Chemical Technology Department, Cape Fear Community College, Wilmington. Holbrook was recently awarded a National Science Foundation (NSF) undergraduate education grant for "Ways to Amplify Teaching and Education in Regard to Science," (W.A.T.E.R.S.), in conjunction with the Chemical Technology Program. The aim is to enhance student learning by strongly reinforcing difficult theoretical concepts in the laboratory environment through the use of state-of-the-art equipment commonly found in an industrial job environment. Students are gaining hands-on training on the use and operation of a purge and trap gas chromatography system coupled with a mass spectrometer (GC/MS) and an ion chromatography (IC) system. It is the first NSF grant given to Cape Fear Community College since 1969.

David Nadig (Ph.D. 1992) worked for Johnson and Johnson for 18 years before joining Vertex Pharmaceuticals in Cambridge, MA as Senior Director, Head of Analytical Development. Nadig oversees the analytical development work for all products from discovery to NDA submissions. Scope of work includes method development and validations (chemical and solid form controls), impurity structure elucidation, stability studies, support of chemical and formulation development, specifications development, and Quality by Design strategies including process analytical chemistry. He has 60 scientists in Cambridge, MA and La Jolla, CA. Vertex has several first-in-class pharmaceuticals in development including products for hepatitis C and cystic fibrosis.

Beverly Pestel (Ph.D, 1983) has joined the Board of Directors of the Sycamore Trails Resource Conservation and Development Council, Greencastle, Indiana. Pestel is on the Special Programs Faculty, Department of Chemistry and Physics, Indiana State University. She is also the owner of PEF Science Consulting, LLC, which does K-16 science education curriculum development. Pestel and her partner, Bill Cary, own Vigo County Woods and spend their spare time in forest management of a series of woodlots in Indiana and Wisconsin. They select mature trees for lumbering and have used their own hardwoods in their home construction. Petel also serves on the Board of the Indiana Forestry and Woodland Owners Association and the Indiana Walnut Council.

Natalie Foster reports that "while suffering from post-massage delirium at Portsmouth Harbor Inn and Spa in Kittery, ME, I was excited to meet fellow spa patron **Pam (Moser) Scheeler (**B.S. 1988)." Pam worked with Joe Merkel and Keith Schray during her Lehigh undergraduate years. After working for Unilever for two years, she moved to Tom's of Maine in Kennebunk, where she develops personal care products. In 1992 her first product came out: Tom's children's toothpaste.

Wayne Foster (B.A. 1983) is a Facial Plastic Surgeon and an Otolaryngology, Head & Neck Surgeon. He is also a triathlete and recently visited the campus for the first time since graduation.

Sean Maguire (M.S. 2009, VMD University of Pennsylvania, 1998), a research veterinarian at GSK, presented his M.S. research, "Modified skin window technique in cynomolgus macaques for assessing neutrophil extravasation," before the American Veterinary Medical Association meeting in Atlanta, August 2, 2010. The pubished work appeared in the *Journal of the American Association for Laboratory Animal Science* **2010**, *49*, 475–479. Sean was mentored in his research by Lehigh Adjunct Professor Katherine Alpaugh of the Fox Chase Cancer Center.

Herbert B. Silber (M.S. 1964), Professor of Chemistry at San Jose State University, was named as a 2010 Fellow of the American Chemical Society.

William E. Tyler III (Ph.D. 1960) writes that he enjoyed the 1941 faculty picture in the last *Mudd in Your Eye* because several people in the picture were still active when he was a student, including H. A. Neville, who as dean presented him with his degree. (Neville and Tyler were both undergraduates at Randolph Macon College.) After leaving Lehigh, Tyler went to work for Exxon Research and Engineering in Linden, NJ, where he spent 33 years before retiring in 1993. While at Exxon he received an M.S. in Computer Science and an M.S. in Applied Math from Fairleigh-Dickinson University. After retiring Tyler was a computer consultant in NJ for ten years before moving to Virginia in 2003. As an amateur astronomer he has been taking taking graduate level astronomy courses at the University of Virginia (UVA), although not for a degree. Tyler finds astronomy "quite exciting" at UVA, especially since the headquarters of the National Radio Astronomy Observatories is on the UVA campus. Tyler's home is on the eastern slope of the Blue Ridge and he hikes there regularly.

Monica Tindel-Koukal (M.S. 2009) has left Ecolabs, a manufacturer of surfactants as industrial cleansers, and has joined the R&D staff of Upsher-Smith Laboratories in Plymouth, MN. Monica is an Associate Scientist in a drug formulation and stability team within Pharmaceutical Development. Upsher-Smith produces and sells generic pharmaceuticals.

Faculty News

Natalie Foster and **Rebecca Miller** were coauthors of "SmartWork: Observations on Student Learning, Faculty Office Hours and Everyone's Attitude," presented at the 21st Biennial Conference on Chemical Education (BCCE) 2010 at the University of North Texas (Denton, TX).

In Memoriam
Roland W. Lovejoy
(1931 – 2010)

Roland W. Lovejoy, Professor Emeritus of Chemistry, passed away on April 19, 2010 in Tucson, AZ as a result of an accidental fall. He was born on June 18, 1931 in Portland, OR. He served on the Lehigh Faculty for 32 years during the period September 1962 to May 1994, retiring in May 1993 and continuing one year as an adjunct faculty member. Roland proceeded through the ranks at Lehigh being promoted to Associate Professor in 1968 and to Professor in 1976.

Roland came to Lehigh after earning a B.A. in Chemistry at Reed College in Portland, OR in 1955, and a Ph.D. in Chemistry at Washington State University with E. L. Wagner in 1960, which was followed by postdoctoral study with Paul C. Cross at the University of Washington 1961–1962.

Professor Lovejoy taught courses in physical chemistry, molecular spectroscopy, quantum chemistry, and thermodynamics. He had a reputation of presenting course material with great clarity and doing most work at the blackboard with exceptionally clear handwriting. Roland's lucidity of thought and presentation in scientific matters caused many students who initially feared the rigor of his style to ultimately admire and love him for it. Precision was reflected in everything he did. He had a well-deserved reputation for being organized and fastidious; in fact, if you visited him in his office you would find on his desk at most one book, one paper and one calculator. On his shelves were models of airplanes, especially jet fighters, as the only items in addition to his assortment of treasured technical books. In research, as befitted his intellectual habits, his laboratory and the work carried out within it was a model of organization.

Roland's research expertise was high resolution infrared spectroscopy. In this area of research the infrared-active vibrations of the molecule under study are identified and the rotational motion is quantitatively studied to deduce the molecular structure and symmetry of the molecule. A typical high-resolution infrared spectrum displays many discrete spectral lines and the work of at least one of his Ph.D. students required the interpretation of over 1000 transitions, a huge number compared to that dealt with in a typical spectrum. Roland mentored five Ph. D. students and eleven M.S. students over his tenure. The molecules whose high-resolution infrared spectra were investigated by his Ph.D. students were germyl acetylene, methyl nitrite and methyl thionitrate, propynyl boron difluoride, monodeuterosilane, and chlorine nitrate. Some of these molecules were of interest in their own right; chlorine nitrate was of interest because it was and is thought to play a role in the Antarctic ozone depletion in the Earth's stratosphere. Other molecules [phosphine, germane, nitrogen pentoxide, and monodeuteromethane] and nitrogen oxide-nitrogen gas mixtures studied by Roland's research group were of interest in modeling planetary atmospheres. His work was supported by NASA-Ames Research Center [Moffett Field, California] and he collaborated with spectroscopists at the National Bureau of Standards (currently NIST). He often likened his work to puzzle solving in which once data were collected, all of the pieces needed to fit together to solve the problem at hand.

Roland W. Lovejoy circa 1975. (Lehigh Special Collections)

Roland did have a marvelous sense of humor that sometimes came out when least expected. One particular instance occurred in the late 1960s at a Christmas skit put on by the student affiliates of the American Chemical Society. The students made a video in which various faculty members were lampooned. The student playing Roland in the video was shown bowing devoutly and worshipping the high-resolution infrared spectrometer. Roland, present at the skit, broke up the house when he interjected "That's not a joke – I actually get my best results that way."

Roland was an avid amateur astronomer and spent a sabbatical leave studying the atmosphere of Jupiter at Kitt Peak Observatory in Tucson, Arizona; previously he had studied gases related to the atmosphere of Venus. Roland built at least two reflector telescopes, grinding his own mirrors, one of which won a prize for its optical quality. He and his wife retired to Tucson and they also maintained a home in Maine where they spent summers until a few years ago. Roland also built radio-controlled airplanes and was an active member of the Tucson Free Flight Club. In late May the free flight club had a ceremony in which some of Roland's ashes were dropped on the flying field from a model airplane. As a very special tribute to Roland, the field was dedicated in his name.

Roland is survived by his wife of 50 years, Deborah Daniels Lovejoy, his two daughters Jennifer C. Lovejoy of Seattle, WA and Suzanne E. Lovejoy of Phoenix, AZ, granddaughters, Teresa S. Straughn and Astrid S. Darlington, and brother Dr. Garvin C. Lovejoy of Portland, OR.

— Written by a Faculty Committee, Daniel Zeroka, Chair

New Alumni Class of 2010

Ph.D. Chemistry

Danielle Nicole Ringhoff – *Dissertation*: Stathmin Regulation of Interphase Cells: Implications for Cancer research.

Ph.D. Polymer Science and Engineering

Samantha Nicola Braganza-Pugh – *Dissertation*: Role of reactive Surfactants in Miniemulsion Polymerization.

M.S. Chemistry

Erik André Aponte, Jonathan Allan Blackwell, Janine Noelle Brouillette, Hao Chen, Peng Cheng, Trevor Alan Daly, Stephen Neil Dirksen, Kimberly D. Ernst, Robert Samuel Foti, Robert Sheldon Francis, Jonathan Michael Ghergurovich, Timothy Andrew Halton, Jennifer Wettstein Hartle, Gerard Michael Koether, Michael Norman Koivula, Candice Patricia Lin, James Ross Merinar, Michael Ai Nguyen, Stephanie Maria Papastephanou, Kelly Meshel Parson, Jolanta Teresa Plewa, Kasey Lyn Prehodka, Susana Ramos Recinos, Jay Scott Reichelsheimer, Rebekah D. Sikora, Yadan Tang, Monica P. Tindel-Koukal, Yung Vuong, Cynthia Lynn Williams, Tyler W. Wood.

M.S. – Polymer Science and Engineering

Mary Christina Benedict, Aidong Zhang.

B.A. Chemistry

Nickolas Theophilos Agathis (Highest Honors, Phi Beta Kappa).

B.S. Chemistry

Steven Roger Ackerman, Renee Carina Nykolak (High Honors), Stefan M. Dainard, Christina L. Marrone.

B.S. Biochemistry

Chetna Bakshi, Sanjana Chandakant Bhatia, Leopold Bonisese III, Caterina Giulia Cellini, Alicia Elizabeth Cutillo (Highest Honors), Brian Edmond Diskin (Highest Honors, Phi Beta Kappa), Katelyn Rose Farrell, Christa Marie Frodella, Grace Anne Heck (Honors), John Holtz, Alison Michele Jaworski (Highest Honors, Honors in Chemistry, Phi Beta Kappa), Edward Roger Mitchell (Honors, Honors in Chemistry), Anand Patel (High Honors), Kevin B. Patel (Highest Honors), Komal G. Patel (Honors), Lisa Renee Rauch, Danielle Alexandra Trause (Highest Honors), Douglas Allen Tremblay (Highest Honors), Destinee Elizabeth Zablocki (High Honors).

B.S. Pharmaceutical Chemistry

Naomi-Liza Denning (High Honors), Nina Marie Patrick.

Student Honors 2010

Brian E. Diskin — American Chemical Society Award presented to the outstanding senior major in chemistry.
Douglas A. Tremblay — American Institute of Chemists Award presented to an outstanding senior majoring in chemistry, chemical engineering or biochemistry.
Steven R. Ackerman — American Chemical Society Inorganic Chemistry Award presented for undergraduate achievement in inorganic chemistry, sponsored by the American Chemical Society Division of Inorganic Chemistry.
Steven R. Ackerman — Merck Index Award presented to an outstanding senior chemistry major who has been active in student affairs.
Alison M. Jaworski — Harry M. Ullman Chemistry Prize presented to the highest-ranking senior in chemistry.
Alicia E. Cutillo — William H. Chandler Senior Chemistry Prize, established in 1920 by Mrs. Chandler, presented to a high ranking senior in the chemistry department. The Chandler Prize is also awarded to a high ranking sophomore and junior chemistry major.
Lillian D. Kull — Alpha A. Diefenderfer/American Chemical Society Analytical Chemistry Award presented to the highest-ranking junior in analytical chemistry, sponsored by the American Chemical Society Division of Analytical Chemistry.
Lillian D. Kull — Hybercube, Inc. Scholar Award presented to a senior chemistry major who has shown outstanding promise in theoretical chemistry and molecular modeling.

Student Chemistry Foundation. Permanent Endowment: To be applied to research scholarships in the Department of Chemistry. Awarded to **Monica Rieth**, sixth-year student working with Assistant Professor Jebrell Glover.

C. Scott Althouse. Quasi Endowment: Established for a memorial fellowship in the field of chemistry. Awarded to **Kyle Wagner**, fifth-year student working with Assistant Professor Dmitri Vezenov

Buch Scholarship. Permanent Endowment: Established by Newton W. and Constance N. Buch. Awarded to **Dong Li**, fourth-year student working with Associate Professor Tianbo Liu.

College of Arts & Sciences Fellowship. Awarded to **Niki Patel,** first-year graduate student (B.A. Chem, Temple University)

University Fellowship. Awarded to **Gabrielle Haddad**, first-year graduate student (B.S. Chem, Moravian College)

Chair's Message

I was fortunate to be on leave during the spring semester and kept myself busy as a visiting professor in the School of Chemistry at the University of Manchester. It was a great experience and while I found the environment intellectually very stimulating, I came back convinced that science education in the US is the finest in the world. The coursework, laboratory training, and degree of interaction among students, postdocs and faculty provides the main foundation for our success. With this in mind, I was pleased to return and see the completion of the STEPS building and the opening of our general and organic undergraduate labs in the new building. Our students in the first two years of chemistry instruction now have modern labs that will greatly enhance their education. The new labs along with teaching by an outstanding faculty and instructional staff including graduate student teaching assistants and Drs. Andy Ho and Jeff Campbell provide our undergraduate students with a world-class education. In the coming years, we anticipate further changes to our teaching and research labs in Seeley Mudd so that students at all levels have top-notch labs.

During the past several months, several faculty have received major funding. In fact, just during the past few weeks, three new major grants have been funded. Bruce Koel received a continuing award from the National Science Foundation (NSF) entitled: Structure and Chemistry of Alloy and Oxide Films at Bimetallic Pt Surfaces. Dmitri Vezenov received an interdisciplinary NSF award with Professor Anand Jagota in Chemical Engineering to work on a project entitled: Coupling Theory and Experiment to Quantify Biomolecule-Nanomaterial Interactions. Finally, Tianbo Liu was recently notified that his NSF International Collaboration in Chemistry grant Nanoscaled Molybdenum-Oxide Clusters: Syntheses, Tuning Surface Properties and Counterion Effects was funded. The funding success of our faculty during the past two years now places us first among all departments in external funding in the College of Arts & Sciences at Lehigh.

We were unable to attract faculty in our two searches last year. We are searching in biochemistry at the assistant professor level and at the senior level for a department chair. Bruce Koel came back to the department from his position of interim Vice President and Associate Provost for Research and Graduate Studies. During his administrative position, Bruce helped initiate Faculty Innovation Grants and doubled the annual investment in Faculty Research Grants. He worked closely with Advancement to help develop the $10 million Smith Funds for Research and Innovation in Science and Engineering, which will provide fellowships to graduate and postdoctoral students and incentive funds for faculty pursuing collaborative research. He also helped create a Research Dashboard that helps the University to define its performance and rise as a research institution through research metrics outlined in Lehigh's Strategic Plan.

In closing, I would like to thank all of you for your updates and news. Your continued support of the department is greatly appreciated.
—Robert A. Flowers. II

Distance Ed and On-Campus Students Complete Graduate Degrees in Academic Year 2009–2010

Lehigh awarded M.S. degrees to 29 students from the Distance Education and the On-Campus graduate programs in academic year 2009–2010. Students completing advanced degrees by distance education and the companies at which they are employed were Erik Aponte (Pfizer), Jonathan Blackwell (Copperhead Chemical), Janine Brouillette (Merck), Stephen Dirksen (NCBFP), Kimberly Ernst (B. Braun), Robert Foti (Amgen), Robert Francis (Sanofi), Jonathan Ghergurovich (GSK), Jennifer Hartle (Albion Pharmaceuticals), Gerard Koether (AstraZeneca), Michael Koivula (Hollistere-Stier), Candice Lin (University of Toronto), James Merinar (Keystone Central), Michael Nguyen (Merck), Stephanie Papastephanou (Drexel University College of Law), Kelly Parson (UPM Pharmaceuticals), Jolanta Plewa (Merck), Kasey Prehodka (BMS), Susana Ramos (Air Products), Jay Reichelsheimer (Pitney Bowes), Monica Tindel-Koukal (Upsher-Smith Laboratories), Yung Vuong (Merck), Cynthia Williams (Lanxess), and Tyler Wood (U.S. Mint). Students completing their M.S. on campus were Hao Chen, Peng Cheng, Trevor Daly, Rebekah Sikora, and Yadan Tang. The Department hosted a congratulatory dinner on the evening before Spring Commencement for the advanced degree graduates.

Seated, left to right: Gerard Koether (AstraZeneca), Stephen Dirksen (attorney–NCBFP), Susana Ramos (Air Products).
Standing, left to right: Keith J. Schray (Interim Chemistry Chairman), Yadan Tang, Peng Cheng, Bu Wang, Ned D. Heindel (Chemistry Professor), Rosemary Makosky (Coordinator–Distance Ed), Hao Chen, and JoAnn Desalvatore (Coordinator–Chemistry)

Spotlight on Alumni: Helene Roth

Born in Bethehem, PA, Helene Kertavage Roth attended Liberty High School, where she came under the influence of Caroline Buzzard**,** a "great chemistry teacher" who was "difficult and exacting" but made chemistry enjoyable for her.

In selecting a college after graduation from Liberty, Roth applied to Lehigh, Penn State, and Pittsburgh. When she went to Lehigh for her interview with Samuel Missimer**,** the director of admissions, she fell in love with the Lehigh campus which Roth admits was unfamiliar to her, even though she grew up nearby,

Living at home and commuting to cut the cost of her education, she started out with an undecided science major, taking biology and chemistry courses, but decided on a chemistry major after her freshman year. "I liked working in a laboratory but preferred chemistry to biology. It seemed more precise to me, and, honestly, I hated the smell of formaldeyde, too!" Lehigh had just gone co-ed a few years earlier, and chemistry was still in the Engineering College, so there were very few women in her classes. This was a change from her high school experience. Yet she developed a strong camaraderie with her fellow students, especially those who were commuters. She found the chemistry professors "very welcoming" and did some work preparing compounds for Kamil Klier in her junior year.

Roth was drawn to analytical chemistry because she liked the instrumentation and she "liked being a bench chemist," which she still is. She enjoys working with her hands and more importantly figuring out an analysis using different methodologies. Roth admits that when she was getting ready to graduate, she wasn't sure what she wanted to do but thought (as did her parents) that she should get a job. She had an idealized vision of what a chemist does, working in a laboratory and doing research.

She interviewed with Philadelphia Electric Co. (later PECO) on campus through Lehigh's Career Services, and was invited to Philadelphia for another interview. It was her only job interview on campus and she started work at the Philadelphia laboratories upon graduation in 1980. For Roth, Philadelphia Electric's chemical laboratories were very diverse and provided different kinds of opportunities for chemists. She worked for nuclear power plants and the instrumentation ran the gamut from gas chromatography to inductively-coupled plasma spectroscopy to wet chemistry. "It was a very wide and broad experience for me."

In 1986 her daughter Emily was born, and Roth chose not to go back to PECO full time. She was offered a job as a contract chemist to PECO (later Exelon) through Interfacts, Inc., which was a manpower organization that did a lot of work at nuclear power plants. Through Interfacts she continued to work for PECO as a consultant on a part-time basis, which she did for thirteen years. During this time she performed analytical testing required for the company's nuclear and fossil generating stations and was responsible for supervision and training of laboratory technicians and the development of laboratory procedures.

In 1999 PECO shifted their focus in chemistry and the work Roth was doing was being phased out. Roth bought into MW Environmental Services, Inc., a company founded a few years earlier to do asbestos air monitoring, and changed its focus to one of servicing the analytical chemistry needs of Exelon and other clients. Located in West Chester, PA, MW Environmental is considered a strategic partner of Exelon, providing all the analytical chemistry needs of Exelon Power Labs, a wholly-owned subsidiary of Exelon Nuclear.

Most of the work MW Laboratories does is analysis of nuclear safety-related materials. There are two forms of that—diesel fuel analysis and contaminant analysis. Every nuclear power plant, like a hospital, has to have emergency diesel generators so if there is a power failure, there is emergency electricity to safely shut the plant down. These generators must be tested monthly, and there are about fifteen tests that need to be done on the diesel fuel, tests performed by MW Laboratories.

In contaminant analysis, any type of material used in a nuclear power plant, such as insulation, cleaners, welding tapes, caulks or adhesives has to meet certain requirements such that it is not going to damage any process or any substrate the material will be used on. While the nuclear power plants may be located globally, the analyses can still be done in West Chester. As owner, laboratory director and quality assurance manager, Roth is responsible for the day-to-day operations of the analytical chemistry laboratory.

Roth, who graduated in 1980, is married to Frank Roth, a fellow Lehigh classmate who is now Lehigh's General Counsel. Her daughter Emily graduated from Lehigh in 2008 and her son Andrew will graduate in 2011. Roth adds that "I had a very nice experience at Lehigh. I enjoyed my time as a chemistry student. It was hard and challenging, but it was rewarding."

The importance of analytical chemistry as exemplified by Roth's work was also stressed by Lehigh in the nineteenth century, when a blowpipe analysis kit (right) was part of the arsenal of every self-respecting chemist. The degree awarded to chemistry graduates — the A.C. degree or Analytical Chemist, was given from 1866 to 1905

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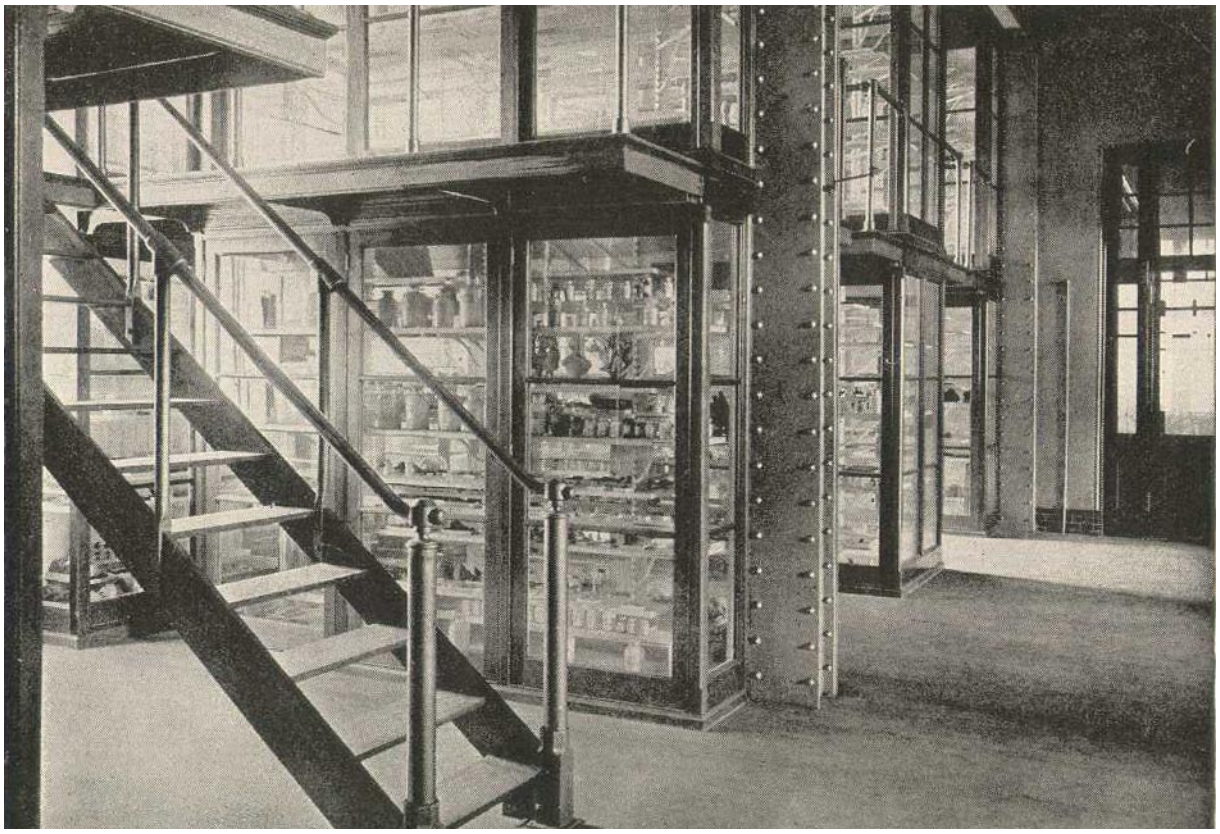

Lehigh University Chemistry Museum, Chandler Hall, circa 1930s