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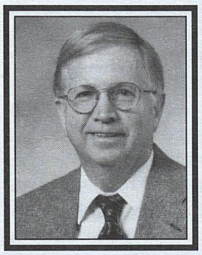
MESSAGE FROM THE CHAIRPERSON, BOYD E. HALEY



Many exciting things are happening for the faculty and students in the Department of Chemistry. Many of our 1999 graduating seniors were accepted into high quality graduate schools and three of them received National Science Foundation pre-doctoral fellowships (a major honor) and several received scholarship support from the institutions that accepted them. Many of our young faculty have received independent external funding, several of the senior faculty were successful in maintaining their individual grants, and some have been successful in obtaining major funding for research centers and graduate training programs.

In the past year the Committee on Professional Training (CPT) of the American Chemical Society (ACS) passed a proposal that required all departments of chemistry to include biochemistry if they wished to be approved to award ACS accredited degrees. This has lead to numerous symposia and workshops dedicated to describing procedures for the "integration" of biochemistry into core chemistry courses and the offering of stand alone courses in biological chemistry. Last year, the Department of Chemistry at the University of Kentucky proposed, through the Research Challenge Trust Fund (RCTF) established by the governor's office, to establish a Biological Chemistry Program that would offer an undergraduate degree in chemistry with a major emphasis in biological chemistry. This would take care of the requirements of ACS for accreditation and also allow the Department of Chemistry to offer a new, and quite popular, area for student training. This would be important for students interested in biomedical or bio-environmental sciences, including pre-medical and pre-pharmaceutical studies as well as other areas. It would also allow the department the opportunity to expand the graduate research program into an area that has available to it a greatly increased pool of federal research funds, especially from the National Institutes of Health. Our proposal to start a Biological Chemistry Program lead to the Department of Chemistry being selected by a University Committee as a Tier One department. Being identified as Tier One meant that our department was identified as one that could reach national prominence with the infusion of reasonable support for expansion.

One of the major assets the department had that lead to the selection as a Tier One RCTF academic unit was the annual Naff Symposium. This Symposium is supported by a generous gift from Dr. Benton Naff that was provided 25 years ago. The establishment of the Naff Symposium was the seed that started the Biological Chemistry Program at the University of Kentucky. We all owe Dr. Naff a major "thank you" for the insight and generosity that he displayed in providing support for this permanent symposium series.

Obtaining the RCTF funds was not accomplished by a single application from the current chair. It is a real compliment to the faculty who were responsible for the quality of the department as it was before I became a member. Two of these faculty, Dr. Joseph Wilson and Dr. Donald Sands, retired this past summer. We are pleased that they have continued to participate in teaching in the Department. Dr. Bill Ehmann and Dr. Robert Kiser, professors emeritus, have also contributed to the quality and collegiality of the department and are continuing to do so.

Additionally, several of the current faculty have made major contributions and have added considerably to the academic and research quality of the department. Dr. David Robertson has redesigned our general chemistry program, updating it with computer assisted learning capabilities. Dr. Mark Meier has been unbelievably successful in converting small amounts of RCTF support into obtaining two new NMRs from the competitive programs of the National Science Foundation. By this spring the Department of Chemistry should have one of the best NMR suites of any major university.

With the selection of the Department of Chemistry to receive RCTF support, we were authorized to hire four new faculty in the area of biological chemistry. The last position was filled when Dr. Edward DeMoll, from the Department of Microbiology & Immunology at the University of Kentucky Medical Center, accepted a position as associate professor. Dr. DeMoll's research area involves a chemical approach to the biochemical mechanisms of anaerobic bacterial metabolism. These are bacteria that are usually quite pathogenic and are involved in the etioloy of numerous human and animal diseases. Our first recruit was Dr. Anne-Francis Miller, from the Department of Chemistry at The Johns Hopkins University, who accepted a position as associate professor. Dr. Miller is an internationally recognized expert in protein NMR and specializes in the study of metal containing enzymes. Her work was recently highlighted in Chemical and Engineering News. She brings an active and very well-funded research program with her. Our most junior recruit is Dr. Stephen Testa from the Department of Chemistry at the University of Rochester, who accepted a position as assistant professor. Dr. Testa is an accomplished young scientist whose research area is the study of antisense RNA as a potential treatment for stopping the expression of specific proteins within living cells. This technology has application to the treatment of many diseases including AIDS and cancer. Our other faculty member is Dr. Tae Ji from the Department of Molecular Biology at the University of Wyoming. Dr. Ji is an established leader in hormone receptor biochemistry and has been continuously funded by NIH since 1972. His work is internationally recognized and he brings a large, active and well-funded research program to our department. It should be noted that these four faculty will compliment an already present group of five faculty with biological chemistry research programs that are also very well recognized and well funded. However, with the arrival of these faculty the Department of Chemistry will immediately start to offer an outstanding program in biological chemistry.

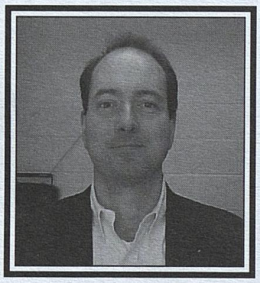
It is to the credit of our current faculty and the faculty search committee that the very difficult job of identifying and recruiting these outstanding faculty was accomplished. Many of the faculty went out of their way to help, and there is no doubt that the credit for the success of this recruitment effort belongs to the entire department and was a major group effort.

The faculty of the Department of Chemistry have scored big in obtaining major external funding. Dr. Robert Haddon received multi-year support from NSF to start a Materials Science Research Center. Drs. Leonidas Bachas, Sylvia Daunert and Art Cammers-Goodwin were prominent in obtaining another major NSF training grant in Biosensor Technology. The funding of these two programs at the multi-

million dollar level indicates the increasing strength and academic reputation of our Department of Chemistry.

Yes, 1998-1999 will be looked upon as a period when the Department of Chemistry had numerous successes, of which a few are mentioned above. We have recruited excellent, well funded, productive new faculty. We have obtained several new pieces of modern equipment through competitive grant applications. Two new major NSF-supported research programs were obtained and many of our faculty have obtained external funding for their research. All of the faculty of the department have contributed to this success and, most importantly, have made the department a collegial and pleasant place to work. My personal thanks to all of them and our wonderful staff who support and tolerate us all.

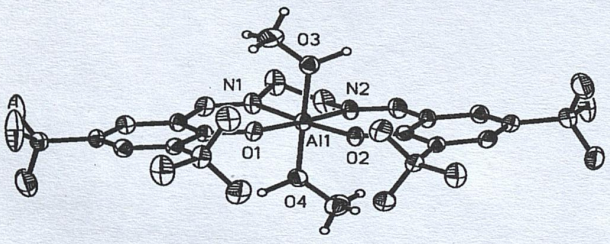
NEW FACULTY



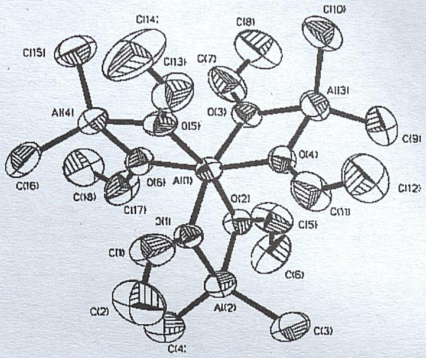
David A. Atwood. David joined our faculty in 1998 as an associate professor. He was born in 1965 in Urbana, Illinois, while his father was in graduate school getting a degree in inorganic chemistry. After graduation from the University of Alabama, David moved to Austin, Texas to attend graduate school at the University of Texas. He graduated with his Ph.D. in inorganic chemistry in the Spring of 1992 but stayed in Austin until his wife, Vicki, finished her doctorate (also in inorganic chemistry). From Texas, he joined the faculty of North Dakota State University as part of their new Center for Main Group Chemistry (of which he was co-director). Since arriving at UK, the Atwood group, comprised of 2 postdoctoral fellows, 6 graduate students, and 4 undergraduates, has produced over 10 publications. David has received an Alexander von Humboldt junior faculty award for the summer of 2001.

Research in the Atwood group is focused on fundamental and applied studies of the main group elements. Currently, the focus is on compounds containing the group 13 elements, particularly aluminum, and on the development of sulfur containing ligands. Whenever possible, they have actively partnered with industry in pursuing the applied aspects of these projects.

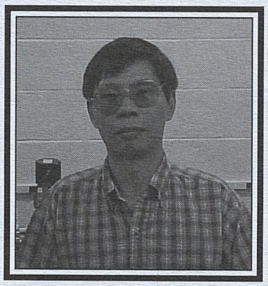
David and his colleagues have systematically characterized and studied six-coordinate group 13 complexes (like $[SalenAl(MeOH)_2]^+$ shown below). Beyond their fundamental interest, these cations act as initiators for the polymerization of oxiranes. They will examine the various organic transformations that these cations may facilitate such as Diels-Alder reactions, the Ene-reaction, and others where the activation of an electron rich substituent (like a carbonyl group) are important. Additionally, they will continue to explore the possibility that the six-coordinate cations may be used in elucidating, the means by which calcium carbonate is formed within biological systems.



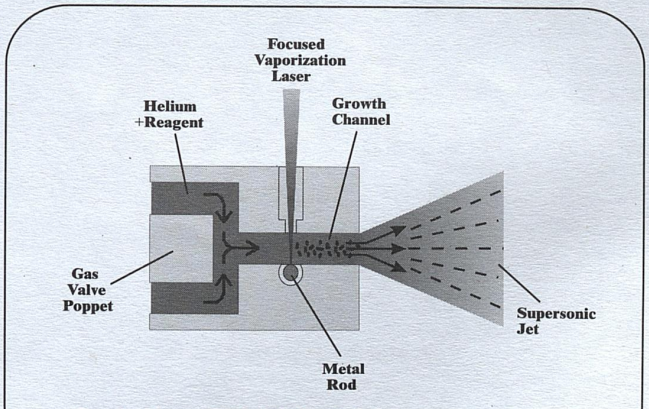
Aluminum oxide, Al_2O_3, has far-ranging utility as a corrosion inhibitor for surfaces and as a packaging material for semiconductor materials. David's group has designed a molecular precursor (shown below) that can be used to prepare alumina at temperatures well-below the conventional preparation temperatures, in some cases at 25°C. It can be used on porous substances where the molecules deep in the pores can form Al_2O_3 in isolation (with heating).



Identifying chemical routes for the removal of mercury and other heavy metals from aqueous sources is another research area of the Atwood group. The primary goal is to identify or develop a chemical remediation agent for the removal of Hg from aqueous sources that is environmentally benign and economical. They propose to do this with a series of newly created ligands that can bind mercury, either as Hg^0, $MeHG^+$, or Hg^{2+}, irreversibly. The ligand is expected to accomplish this by forming a four-coordinate, tetrahedral, sulfur chelate around the Hg metal. They are actively seeking the input of companies interested in remediation in order to develop the large-scale applications of this chemistry.



Dong-Sheng Yang. Dong joined the faculty as an assistant professor in January, 1998. He received his doctoral degree in chemistry from the University of Western Ontario, Canada. Following the graduation, he worked first as a research associate and then as a research officer at the Steacie Institute for Molecular Sciences, National Research Council of Canada in Ottawa. His research focuses on the creation and characterization of novel metal and semiconductor aggregates. The aggregate may consist of atoms of a pure metal and alloy, mixtures of a metal with a metalloid or a nonmetal, or it may be a metal center with molecules bound to it. He and his group synthesize the aggregates using laser vaporization supersonic jet techniques (see the Figure) and analyze the products using laser photoelectron, photoionization, photodissociation, and time-of-flight mass spectrometric methods. The work is fundamental, but practical implications are easily found in thin-film deposition for microelectronic devices, chemical sensors, catalytic transformation of chemicals, and selective metal ion transportation through cell membranes.



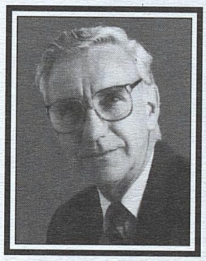
Production of Metal-Containing Aggregates

PROMOTION

Sylvia Daunert. Sylvia was promoted to associate professor with tenure in 1998. She began work in our department as an assistant research professor in 1990 after completing her Ph.D. in bioanalytical chemistry at the University of Barcelona, Spain. Sylvia's research interests lie at the interface between analytical chemistry and molecular biology. Specifically, her group employs recombinant DNA techniques to understand biomolecular recognition events and to design new molecular biosensors.

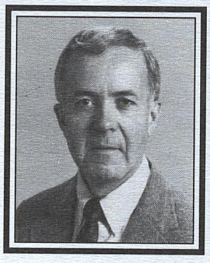
Sylvia's research has been amply funded almost from the day she joined our department. She has already amassed over two-and-a-half-million dollars in research grants as principal investigator or Co-PI since 1992. Sylvia and her group have produced more than fifty research papers since her arrival at UK. She has received several awards, including the Lilly Award in Analytical Chemistry in 1997 and 1998 and the Research Corporation Cottrell Scholar Award in 1997.

RETIREMENTS



Donald E. Sands retired and became Emeritus Professor of Chemistry in May 1999. Don, a native of Leominster, Massachusetts, received his B.S. from Worcester Polytechnic Institute and his Ph.D. from Cornell University under the direction of J. L. Hoard. After six years at Lawrence Livermore National Laboratory, he joined our faculty in 1965, where he became Professor of Chemistry in 1968. Don has served as Director of General Chemistry and Chair of the Department, Associate Dean and Acting Dean of the College of Arts and Sciences, and Vice Chancellor for Academic Affairs for the University. In addition, he served three years as Section Head of the National Science Foundation Division of Teacher Preparation and Enhancement.

Don has published over 50 research articles and authored two textbooks. His research has emphasized crystallography, motion in crystals, and tensor properties of crystals. As the Department and University drew upon Don's time and resources for leadership, chemical education became the focus of his research. His contribution to this area has been recognized at both the national and international level. In addition to his time at NSF, Don helped develop educational programs in Indonesia and Malaysia. It is only natural that President Wethington should call upon him during his last year at UK to chair the President's Task Force on Mathematics, Science and Technology Education. Don's long and distinguished service is greatly appreciated by the Department, the University, and the scientific community.



Joseph W. Wilson retired and became Emeritus Professor of Chemistry in May 1999. Joe, a native of Massena, New York, received his B.S. from Massachusetts Institute of Technology and his Ph.D. from Indiana University. After a two-year postdoctoral appointment at the University of Wisconsin, he joined our faculty in 1963 and was promoted to Associate Professor of Chemistry in 1969. Over the course of his career, Joe has stepped forward and served the Department as Director of Graduate Studies, Director of Undergraduate Studies, Director of General Chemistry and Acting Chair of the Department. We are truly grateful for his unselfish attitude toward service and were pleased that the University acknowledged Joe's many contributions by promoting him to professor.

Throughout his career, Joe has been recognized as one of the University's finest teachers. He was awarded the University of Kentucky Alumni Association Great Teacher Award in 1975 and the College of Arts and Sciences Outstanding Teachers Award in 1992 and was named one of the Top 10 Professors by the 1997 graduating

EMERITUS FACULTY

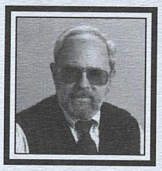
Dr. William D. Ehmann (Ph.D., Carnegie Mellon University, 1957), born 1931 Madison, WI, educated at the University of Wisconsin-Madison and Carnegie Mellon University, postdoctoral fellow and consultant for Argonne National Laboratory. At UK 1958-95. Department Chairman 1972-76. Radiochemistry.

Dr. Robert W. Kiser (Ph.D., Purdue University, 1958), born 1932 Rock Island, IL, educated at St. Ambrose College and Purdue University, faculty member at Kansas State University. At UK 1967-97. Department Chairman 1968-72. Inorganic Chemistry.

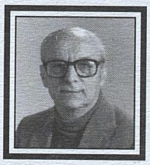
Dr. Kurt Niedenzu (Dr. rer. nat., University of Heidelberg, 1956), born 1930 Fritzlar, Germany, educated at the University of Heidelberg, worked for U.S. Army Research Office, Durham, NC and for Wintershall AG, Germany. At UK 1968-92. Inorganic Chemistry.

Dr. John M. Patterson (Ph.D., Northwestern University, 1953), born 1926 Vineland, NJ, educated at Virginia Military Institute, Wheaton College, and Northwestern University. At UK 1953-93. Organic Chemistry.

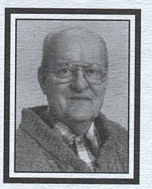
Dr. Paul G. Sears (Ph.D., University of Kentucky, 1953), born 1924 Somerset, KY, educated at the University of Kentucky, worked at Monsanto Chemical Co. At UK 1954-57 and 1959-90. Special Assistant to the President, 1971-90. Physical/Inorganic Chemistry.



Dr. Stanford L. Smith (Ph.D., Iowa State University, 1961), born 1935 Detroit, MI, educated at Albion College and Iowa State University, postdoctoral fellow Iowa State. At UK 1962-97. Organic Chemistry.

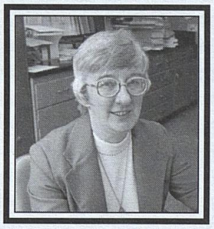


Dr. Walter T. Smith, Jr. (Ph.D., Indiana University, 1946), born 1922 Havana, IL, educated at the University of Illinois and Indiana University, worked at Mallinckrodt Chemical Works and the Ethyl Corporation, taught at the University of Iowa. At UK 1953-92. Organic Chemistry.

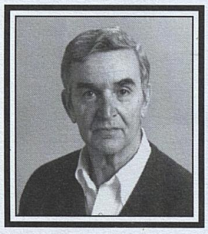


Dr. William F. Wagner (Ph.D., University of Illinois, 1947), born 1916 Canton, MO, educated at Culver-Stockton College, the University of Chicago, and the University of Illinois, worked for Illinois State Geological Survey and taught at Hanover College. At UK 1949-83. Department Chairman, 1965-68 and 1976-83. Analytical Chemistry.

OBITUARIES



Dr. Audrey L. Companion, Emeritus Professor of Chemistry at the University of Kentucky, died of congestive heart failure on January 17, 1999. Audrey, a native of Pennsylvania, received her B.S., M.S. and Ph.D. degrees from Carnegie Institute of Technology. She began her academic career in 1958 at the Illinois Institute of Technology and joined the University of Kentucky as an Associate Professor in 1975. Audrey served the Department as Director of Graduate Studies from 1977-1981. Her areas of research included theoretical models for chemisorption and catalysis, computer simulation of erosion and embrittlement of metals, storage of hydrogen by metals, and large scale *ab initio* studies of diatomic molecules or molecular ions formed in the sputtering process. Dr. Companion's book, *Chemical Bonding*, was an award-winning text that achieved record sales. After retiring from the University in 1992, Audrey remained active in community organizations and taught computer skills to senior citizen groups. She will be remembered for her high professional standards, quality teaching, and concern for both the academic and personal problems faced by her students.



Dr. Paul L. Corio, Emeritus Professor of Chemistry at the University of Kentucky, died of cancer on August 15, 1998. Paul, a native of New Haven, Connecticut, received his B.A. from Columbia College, New York and his M.A. and Ph.D. degrees from Columbia University. Following a two-year tour of duty in the U.S. Navy, Paul joined Mobil Oil Company as a research chemist in 1957. After six years as Group Leader of the Central Research Division in Princeton, New Jersey, Paul joined the chemistry faculty of the University of Kentucky as an Associate Professor in 1970.

Dr. Corio's early work on the theory of nuclear magnetic resonance, and his book, *Structure of High-Resolution NMR Spectra*, was a seminal contribution to the field. His was an authoritative voice on the quantum theory of angular momentum. In more recent years, Paul's interests extended to chemical kinetics, reaction mechanisms, and group theory.

In addition to his research contributions, Paul will be remembered as a highly respected and popular teacher. Along with his deep knowledge of chemistry was a facility for making connections with other subjects and with the everyday experience of students. He was a gifted speaker and was able to bring clarity to difficult concepts. He had high expectations for student performance and, in exchange, was able to bring out the best in students.

Dr. Edward J. Griffith passed away on June 12, 1998, and was buried in his home state of Alabama. Ed received his doctoral degree under the direction of Lyle Dawson in 1951. He joined Monsanto Chemical Company immediately following completion of his graduate work and was with Monsanto for 48 years of distinguished service. For the majority of that time, Dr. Griffith was a Senior Scientist in the company with the freedom to engage mostly in the research of his choice.

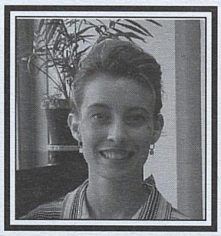
Mrs. Dorothy Brown Masters of Glenmore Heights, KY, died on March 5, 2000. We will remember Dorothy as the lively wife of Professor Ellis V. Brown, who retired in 1975 but continued to work in his lab for many years before his death in 1992.

Dr. Kurt Starke, Associate Professor in our Department in the late '50s and early '60s, died on January 19, 2000, in Marburg, Germany. Kurt, a student of Nobel Laureate Otto Hahn, initiated the radiochemistry program at the University of Kentucky and later became professor and institute director at the University of Marburg.

Mr. David Wilson Young passed away on April 25, 1999 in Chicago Heights, Illinois. David received his B.S. and M.S. degrees in chemistry from the University of Kentucky in 1931 and 1935, respectively. He worked as a research scientist for several firms during his career and owned a consulting business. David held numerous patents from his work in the petroleum industry. He was the president of the American Institute of Chemists in 1969-70. In 1996, Mr. Young established a scholarship for undergraduate chemistry majors at UK in memory of his late wife, Eloise Conner Young.

Dr. William H. Zuber, Jr. passed away on March 24, 1998 following a heart attack. He was actively teaching at the University of Memphis until the day before his death and a scholarship has been established in his memory for chemistry students at the University of Memphis. Bill received his Ph.D. in 1964 under the direction of L. R. Dawson and H. C. Eckstrom.

NEW FACES AROUND THE DEPARTMENT



Autumn Adams. Autumn is the Program Coordinator for IGERT Fellowship Program, Integrated Sensing Architectures, headed by Leonidas G. Bachas. She started working at the University in August of 1998 and is also a graduate of the University of Kentucky with a Bachelor's Degree in Communications. Autumn and her husband Bryan have been married for almost 2 years.

Sherri Caudill. Sherri replaced Yvonne Beatty-Warner in our Business Office as of September 27, 1999. Sherri was born in Cincinnati, Ohio and raised in Central Florida. She is currently finishing her degree in office systems technology at Lexington Community College and plans on going into office management. Sherri came to the University in August of 1997 as a Staff Assistant for Mechanical Engineering where she also worked for the Director of Graduate Studies and the Chairman. Sherri and her husband, Charles, have four children (ages 6, 7, 9, and 12) from their previous marriages and are currently working on a child together.

Edward Duhr. Ed is a scientific technical specialist working in our stockroom. He is an Iowan by birth and education who came to the University in 1985 by way of Wyoming. Through his long association with Professor Haley's lab, he wound up in the Chemistry Department. This is rather fitting because his degrees are in chemistry.

Chris Showalter. Our new Business Manager replaced Amy Kirkpatrick in July, 1998. She is originally from New Bremen, OH and received her Bachelor's Degree in Business Administration from Ohio University. Chris joined the University in January, 1994 as an Account Clerk in the Physics Department. Before joining the Chemistry Department, Chris held administrative staff positions in the Arts & Sciences Dean's Office and the Continuing Medical Education Office. Chris and her husband, Brent, are the proud parents of their 2-year-old daughter, Megan, and 6-month-old son, Alan.

ALUMNI RESEARCH HIGHLIGHTS

One of the best indicators of the quality of an academic program is the success of its graduates, and we are not above basking in the reflected glory of our current and former students.

We are pleased to announce that this past year three of our graduating seniors were awarded NSF Graduate Fellowships. These highly competitive and prestigious awards will provide financial support for Adam Breier, Shane Foister, and Lori Watson to continue their studies in chemistry at the graduate schools of their choice. Only six universities in the country had three or more students receive these three-year fellowships. They are, in addition to UK, Cornell, Harvard, MIT, Princeton, and Rice.

In order to keep your informed about the success and achievements of our graduates, we include a new feature in this newsletter that we hope will become a regular addition – highlighting the accomplishments of an alum. This year, we have chosen to report on the research of the thin-film battery team at Oak Ridge National Laboratory (ORNL) that is lead by John Bates. John received his bachelor's degree in chemistry at the University of Kentucky in 1964, and he elected to remain at UK and study under the direction of Hartley Eckstrom. Following the untimely death of Professor Eckstrom, John completed his dissertation on "*The Infrared and Raman Spectra of Some Molecular Crystals*" with Don Sands in 1968. After a one-year appointment as a research associate at the University of Maryland, John joined the scientific staff of the Chemistry Division or ORNL in 1969. He was appointed as a group leader in the Solid State Division in 1973. John has written over 180 articles and 3 book chapters and has been awarded 10 patents. Included in his publications are invited review articles in the *Encyclopedia of Advanced Materials*, *Physics Today*, and *Science*. Following is a brief description of the current work of the thin-film battery research group that John leads at ORNL.

The Development of Thin-Film Batteries

Research over the past decade at Oak Ridge National Laboratory (ORNL) has led to the development of a new technology, thin-film rechargeable lithium and lithium-ion batteries. The batteries, which are less than 15 μm (micrometers) thick, can be deposited directly onto semiconductor devices or chip packages in any shape or size, and they can be recharged thousands of times. Applications under commercial development for the near term, 2-3 years, include rf identification tags for real-time inventory and theft protection of consumer products, backup power to maintain memory of CMOS chips, and power sources for implantable medical devices such as pacemakers, defibrillators, and neural stimulators. As manufacturing costs decline, thin-film batteries could also be used in cellular telephones and laptop computers. License agreements have been signed with several companies, and manufacturing scale-up is under way. In addition, to their practical applications, thin-film batteries are important unique research tools for characterizing the physical and chemical properties of lithium intercalation compounds.

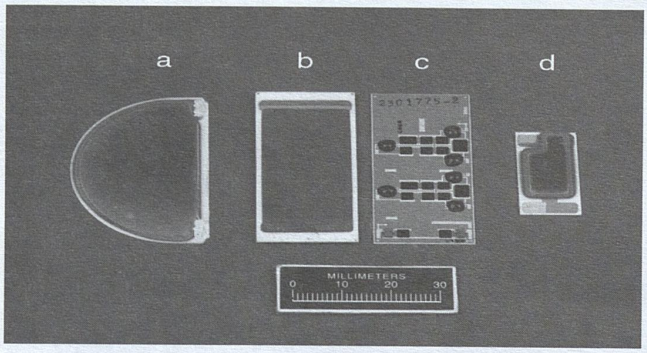
The project to develop thin-film rechargeable lithium batteries began at ORNL in 1987. Having researched the physical and chemical properties of a variety of ceramic ionic conductors, our group became intrigued with the possibility of developing a totally solid state thin-film rechargeable lithium battery. At the outset, we chose the common industrial film deposition methods of sputtering and evaporation, recognizing that expensive methods, such as laser ablation or molecular beam epitaxy, would likely prohibit commercialization. In order to achieve the highest possible cell potential and the highest energy densities, the cathode would need to be a transit ion metal oxide lithium intercalation compound and the anode metallic lithium. It was clear that finding a solid electrolyte having an acceptable Li^+ ion conductivity *and* the requisite electrochemical stability, >5 V vs. Li, would be our biggest challenge. After several years of research on thin film lithium electrolytes, we discovered in 1993 that sputtering Li_3PO_4 in N_2 gas produced a new amorphous electrolyte, lithium phosphorous oxynitride, or "Lipon," that had an acceptable lithium ion conductivity. More important than the ion conductivity, this new material was stable in contact with metallic lithium at potentials from 0 to nearly 5.5. Dave Robertson's development of a rapid, accurate analytical technique for determining the Li content of Lipon at the UK Van de Graaff accelerator was an important part of this research.

The discovery of Lipon was the breakthrough we needed to develop thin film lithium batteries. In the succeeding years, our research focused on the deposition and characterization of thin film transition metal oxide cathode materials including V_2O_5, $LiMn_2O_4$, and $LiCoO_2$, whose crystal structures allow Li^+ ions to be inserted and extracted. As Li^+ ions and electrons move into and out of these compounds when the thin film lithium battery is discharged and recharged, the valence of the transition metal ions changes to maintain charge neutrality. The shapes of the discharge profiles (i.e., battery potential vs. the quantity of charge inserted into or extracted from the cathode) is determined by the difference in the chemical potential of lithium in the anode and lithium in the cathode. This difference depends upon the chemical composition of the cathode and its physical form (whether it is crystalline, nanocrystalline, or amorphous). With crystalline $LiCoO_2$, for example, the potential vs. Li is relatively constant at about 4 V.

New results obtained within the last 12 months include the fabrication of highly textured crystalline $LiCoO_2$ films with a preferred orientation that results in batteries capable of exceptional discharge and charge rates of up to 20 mA/cm^2, the development of defect models for crystalline and nanocrystalline $LiMn_2O_4$ spinels and lattice models that yield the elastic properties and other properties of $LiCoO_2$, and the synthesis of a new class of glassy inorganic lithium-ion anode materials in the silicon-tin oxynitride system. These new anode materials have enabled the development of lithium-ion batteries that can withstand the high temperatures required (250-300°C) for solder reflow assembly of electronic circuits.

Research on thin film batteries and materials will wind down over the next several years as we complete several studies of a few remaining interesting, but non-critical problems, and finish a number of manuscripts. While we will continue to offer assistance to our present and new licensees in commercializing thin film batteries, our materials research programs will be refocused on new opportunities such as solid state electrochemical actuators.

Thin Film Battery Group. Standing left to right: John Bates, Thitima Suwannasiri (postdoc), Ivan Dunbar, Atsushi Ueda (postdoc). Seated: Nancy Dudney, Bernd Neudecker. Not pictured: Chris Luck, Don Evans.



Examples of Thin-Film Lithium Batteries. A: One cell of a D-shaped Li-$LiCoO_2$ battery (7.5 cm^2) for an implantable defibrillator. B: Li-$LiCoO_2$ battery (5 cm^2) fabricated on the back-side of a multichip module ceramic package. C: Circuit on front side of package. This prototype preamplifier illustrates how thin film batteries can be integrated into electronic circuits. D: Laboratory cell (1 cm^2 active area) for characterizing the electrochemical properties and performing in-situ x-ray diffraction of cathode and anode materials as a function of lithium concentration.

MORE NEWS OF ALUMNI AND ALUMNAE

Charles C. Randall, B.S. 1936, M.D. (Vanderbilt) 1940, is Professor Emeritus of Microbiology at the University of Mississippi Medical Center in Jackson, MS.

David L. Flanders, B.S. 1937, retired from B. F. Goodrich after 43 years of service.

James T. Tanner, Ph.D. 1966, has retired from the FDA and has moved to Harrodsburg, KY. He continues to do consulting.

James A. Cunningham, Ph.D. 1968, after 26 years in Dayton is now Executive Director for the Electronic Systems Center at Hanscom Air Force Base in Massachusetts.

David Lorenz, B.S. 1975, is Director of Sales and Marketing at Sun International.

Edgar C. Nicolas, Ph.D. 1980, is now Director of the Analytical Sciences Department at Sanofi Research in Malvern, PA. Because Sanofi is a French company, he travels to Europe frequently.

J. Carlin Gregory, B.A. 1981, M.S. 1983, is a Staff Chemist at Texas Gas Transportation Corporation. He recently moved back into the chemistry lab after 13 years in corrosion control.

Jeffrey D. Hord, B.A. 1985, M.D. 1989, is an Assistant Professor of Pediatrics in the Division of Pediatric Hematology/Oncology at the University of Pittsburgh School of Medicine. He is the director of the hospital's Sickle Cell Program.

Bryan R. Payne, B.A. 1988, is now Chief Resident of Neurosurgery at the LSU School of Medicine.

Richard A. Gatenby, Ph.D. 1990, has moved to Milwaukee where he is a senior clinical medical physicist at St. Luke's Medical Center.

Yi Zou, Ph.D. 1993, is a Research Scientist in Analytical Development in the Consumer Products Division at Park-Davis of Warner-Lambert. He and his wife traveled back to China in late 1996 and report that many changes have taken place since they left.

Alice Taylor Schelling, B.A. 1994, B.B.A. (Management) 1997, is in the Office of the Vice Chancellor for Research and Graduate Studies at the University of Kentucky.

Rob Watterson, B.S. 1994, is now a Medical Resident at Albert Einstein Medical Center in Philadelphia, PA after completing his M.D. at the University of Cincinnati in 1998.

Kathryn L. Ackley, B.A. 1995, continues to work towards her Ph.D. at the University of Cincinnati.

Christopher A. McGrath, Ph.D. 1996, has been appointed as a staff scientist at Idaho National Engineering and Environmental Laboratory in Idaho Falls.

Minfang Yeh, Ph.D. 1997, has recently moved to Sudbury, Ontario, Canada, to work at the Sudbury Neutrino Observatory as an employee of Brookhaven National Laboratory.

Erick J. Palmer, B.A., 1997, now a graduate student in chemistry at Ohio State University, has been awarded a Seaborg Institute Summer Fellowship to work at Los Alamos National Laboratory during the summer of 2000.

Mohammad W. A. Kadi, Ph.D. 1998, has been appointed as an assistant professor at King Abdul Aziz University in Jeddah, Saudi Arabia.

Shane Foister, B.S. 1998, a Ph.D. candidate at Caltech, has joined Peter Dervan's research group. He now believes that UK does a first rate job training undergraduate students and thinks that the research program here contributed to his education greatly.

Christopher B. Martin, B.A. 1999, is in graduate school in chemistry at Ohio State University, where he is using Bob Grossman's book. He also praises the time he spent at UK doing research and thinks that this experience has provided him with an edge in graduate school.

RESEARCH NEWS

In the last newsletter, we told you about the research activities of three of our "rising stars." This year we include brief descriptions of the research programs of three of our senior faculty (D. Allan Butterfield, Robert C. Haddon and Steven W. Yates) whose work has received both national and international recognition. Both Allan and Steve have been honored by the University in being named University Professors and in receiving the William B. Sturgill Award for Outstanding Contributions to Graduate Education. Steve has also been named Distinguished Professor of the College of Arts & Sciences (1993) and Allan recently received the Southern Chemist Award from the Memphis Section of the American Chemical Society (1997). Robert joined the Department in 1997, and we anticipate that the University will soon honor him in a similar fashion. While at Bell Laboratories, Robert was named a Fellow of the Royal Australian Chemical Institute (1988), a Fellow of the American Association for the Advancement of Science (1993), and a Fellow of the American Physical Society (1996). As a group, Allan, Steve and Robert have published over 600 research papers and mentored 27 Ph.D. and 20 M.S. students. Their research programs are currently supported by major grants from NSF, NIH, DOE and DoD. Clearly, these three individuals are maintaining the tradition of excellence and are setting the standard for future faculty in the Department.

Oxidative Stress Research Related to Alzheimer's Disease

D. Allan Butterfield. The effects of oxidative stress on neuronal systems in aging and age-related neurodegenerative disorders such as Alzheimer's disease (AD) are the focus of our research program. Oxidative stress, usually manifested by increased protein oxidation, lipid peroxidation, reactive oxygen species (free radical) production, or peroxynitrite damage, is thought to result from increased production of free radicals or a decline in antioxidant defense systems. Both phenomena occur in aging.

An excess amount of a peptide called amyloid β-peptide (Aβ) is deposited in AD and there is increased oxidative stress in AD brain. Many researchers now believe that Aβ is central to the pathogenesis of AD. Our laboratory showed that increased protein oxidation (measured by increased protein carbonyl levels) occurs in AD brain regions rich in Aβ, but not in regions poor in Aβ. Similarly, Dr. Bill Markesbery and Dr. Mark Lovell have shown increased lipid peroxidation in AD brain. We developed a hypothesis that relates both Aβ-related phenomena: namely, that Aβ itself was associated with free radical oxidative stress that leads to neurotoxicity in the AD brain.

To test this idea, we used electron paramagnetic resonance, the only technique that can directly detect free radicals, to demonstrate that Aβ was indeed associated with free radical oxidative stress.

Others have confirmed this finding. Our laboratory then studied the effects of Aβ on brain membrane systems to see if this peptide would lead to cell death. Using a variety of biophysical and bioanalytical methods, we demonstrated that, in ways completely inhibited by free radical antioxidants, Aβ induced: (a) brain membrane lipid peroxidation; (b) brain cell protein oxidation; (c) ROS formation; and (d) neuronal cell death. A major lipid peroxidation product is 4-hydroxy-2-trans-nonenal (HNE). This compound adds to cysteine SH groups and other amino acids by Michael addition. Aβ added to neurons leads to formation of HNE, and, at these concentrations, HNE caused large changes in brain membrane protein conformation. These changes likely account for alterations in neuronal transport function by Aβ and HNE. Since HNE was found to be in excess in AD brain, it is possible that this agent accounts for altered function of many proteins in this disorder.

Research in our group also showed that neuronal protein oxidation induced by Aβ was inhibited by the free radical scavenger vitamin E and that vitamin E also blocked Aβ-induced lipid peroxidation, ROS formation, and inhibition of Na^+/K^+-ATPase. The latter study was performed collaboratively with Dr. Mark Mattson of the UK Center on Aging. Inhibition of this enzyme would lead to opening of voltage-controlled Ca^{2+} channels, and since there is a 10,000-fold concentration gradient of this ion, excess Ca^{2+} would accumulate inside the neuron. Indeed, Dr. Mattson's and our groups have found that Aβ leads to excess Ca^{2+} accumulation, leading to subsequent detrimental processes that eventually kill the neuron, exactly in accordance with our hypothesis for neurotoxicity in AD brain.

A different oxidative stress pathway, but related to Aβ, involves peroxynitrite. This anion is formed by rapid reaction of superoxide radical anion with nitric oxide. The latter is produced with catalytic assistance of nitric oxide synthetase, which is stimulated by Aβ. Superoxide radical, though formed in many reactions, is principally produced in mitochondria and leaks from this organelle. Peroxynitrite rapidly reacts with tyrosine residues to form 3-nitrotyrosine, which, because of its proximity to the OH group on tyrosine, prevents phosphorylation of the latter, thereby blocking a key step in cell signaling, a detriment to the cell. This anion may also lead to free radicals through breakdown to NO_2 and OH radicals. Our group recently showed that peroxynitrite greatly alters the conformation of brain membrane proteins, leads to significantly increased protein oxidation and neuronal cell death. The endogenous free radical scavenger, glutathione, blocks these alterations. These results are particularly exciting in that they have implications of therapy in AD.

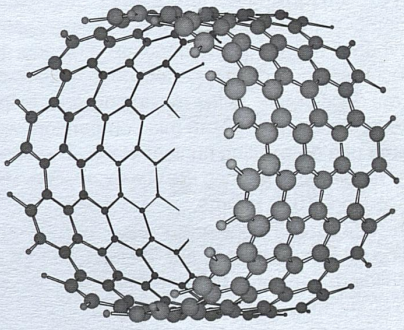
Mechanistic studies are ongoing in our lab to try and better understand Aβ-associated free radical oxidative stress. It is possible that redox metals play a role in this phenomenon. Harvard researchers have shown recently that Aβ will reduce Cu^{2+} to Cu^+, i.e., like our findings, the peptide transfers an electron to the metal ion leaving a free radical on the peptide. Our studies point to a role for methionine in the oxidative stress properties of Aβ and that if methionine is replaced by different amino acids or removed all together, no EPR signals, no protein oxidation, and no neurotoxicity results. These *in-vitro* studies were recently supported by *in-vivo* studies in our laboratory. In collaboration with a scientist at the University of Colorado, who provided transgenic worms, *C. elegans*, in which human Aβ was expressed, we showed a nearly 100% increase in protein carbonyl levels over the vector control. If methionine were mutated to a different amino acid the Aβ expressed in the transgenic worm, no increased protein carbonyls were found, consistent with a role for methionine found in the *in-vitro* studies noted above. These *in-vivo* studies also are consistent with our earlier studies showing increased protein carbonyls in AD brain.

Carbon Nanotubes

Robert C. Haddon. Our group is interested in the synthesis, electronic structure and properties of molecules and materials. Particular emphasis is placed on transport, magnetism, superconductivity, device fabrication and miniaturization, and the discovery of new classes of electronic materials. We are currently working on the synthesis and solid state properties of neutral carbon-based radicals, carbon nanotubes and organic light-emitting diodes. Our work on carbon nanotubes [CNTs] was recently reported in *Science*, (*282* (1998) 95) and highlighted in *Chemical and Engineering News* (October 5, 1998).

All previous work on CNTs (both single-walled and multi-walled), has been carried out on the unusual intractable, insoluble form of this material. This form of the material is not amenable to many of the processing steps that are necessary if the CNTs are to reach their full potential -- particularly in applications that require these materials in the form of polymers, copolymers, composites, ceramics and moldable forms. While some of the present forms of the CNTs can be heterogeneously dispersed in various media, the interactions between the CNTs and host and between the CNTs themselves are simply physical, and without the formation of chemical bonds the advantageous properties of the CNTs are unlikely to be realized on a macroscopic level. What is needed is a method to prepare well-dispersed forms of CNTs by inducing them to dissolve in organic solvents. Although long believed to be impossible, we have discovered such a procedure for the dissolution of SWNTs. Naked single-walled nanotube carbon metals and semiconductors were dissolved in organic solutions (s-SWNTs) by chemical processing of the nanotube end groups. Both ionic (charge transfer) and covalent solution phase chemistry with concomitant modulation of the SWNT electronic band structure were demonstrated. Solution phase near-IR spectroscopy was used to study the effects of chemical modifications on the band transitions of the SWNTs. Reaction of s-SWNTs with dichlorocarbene led to functionalization of the nanotube walls.

Chemical Attachment of Organic Functional Groups to Single-Walled Carbon Nanotubes

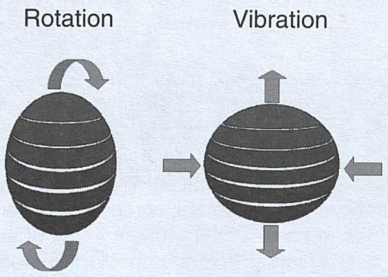


Subatomic Chemistry

Steven W. Yates. I usually describe my work at UK as basic nuclear structure research, but Bob Guthrie has suggested that we need a more alluring image and that what I actually do is "subatomic chemistry." I kind of like that description and think I'll use it, at least until Bob comes up with something even better.

The basic goal of our work, understanding the fundamental properties of atomic nuclei, has remained unchanged since I arrived at UK in the Summer of 1975. The most exciting developments in this area are in the unfolding of our knowledge of various so-called collective modes in nuclei. These excitations represent correlated motions of a large number of nucleons, neutrons or protons, in the nucleus. The simplest collective excitations can be visualized by analogy with the motion of a soap bubble, which can vibrate and rotate around an axis; these are called vibrational and rotational modes and have direct analogs in molecules. Rotations can only occur in a quantal

system where the shape of the nucleus is non-spherical while vibrations can occur in nuclei of any shape. Vibrations and rotations in nuclei, such as those shown below, have been known for many years, but it is only now that we are truly beginning to understand these phenomena and their properties.



It is fascinating that nuclei can undergo even more complex modes of vibration. A focus of our work for many years has been on understanding "octupole" vibrations in nuclei. These octupole modes can be visualized as pear-shaped oscillations of the nucleus. (Imagine the stem being pulled through the pear so that the resulting pear is now oriented in the opposite direction.) Only recently have we confirmed that nuclei which are basically spherical in their ground states can exhibit multiple octupole oscillations. The exciting new finding has inspired several theorists to get into the act, and sophisticated calculations to explain our results are rapidly emerging.

Measurements of nuclear lifetimes are very important in determining the degree of collectivity of excited nuclear states. One of the most important methods for determining the lifetime of a nuclear state is the Doppler-shift method, which is based on the Doppler effect that can be observed as a shift in the frequency of the horn of an ambulance as it approaches and then passes. In our case, this means that, when an excited moving nucleus emits a gamma ray while approaching a detector, the detector observes an increased frequency or energy. When it moves in the opposite direction, the detector observes a decreased energy. This effect enables us to compare the time scale of the deceleration of the moving nucleus in the surrounding material to its decay rate. From this comparison, we can determine the lifetime of a de-exciting nuclear state. The observable lifetimes with the Doppler-shift method are very short, in the femtosecond (10^{-15}) to picosecond (10^{-12}) regime.

At the Van de Graaff accelerator laboratory (that cylindrical-shaped building on Rose Street at the "physics end" of the Chemistry-Physics Building), we have developed an array of experimental techniques to study the phenomena described above. Primarily, we employ the inelastic scattering of accelerator-produced neutrons to excite the nuclei into these interesting modes and shapes. As uncharged particles, neutrons permit us to probe the nucleus gently, and we do not unnecessarily perturb the system we wish to study.

Much of the credit for our success must go to the graduate students who have worked with us during the past twenty years. Through the efforts of Albert Filo (M.S., '79), Beth Kleppinger (Ph.D., '84), and Aman Khan (Ph.D., '85), we were able to develop the tools necessary to see the advantages of using fast neutrons as nuclear probes. The excellent work of Rich Gatenby (Ph.D., '90), Lee Johnson (Ph.D., '93), Ed Baum (Ph.D., '93), and David DiPrete (Ph.D., '94) provided ample evidence that our experimental methods could provide information that was simply unattainable with other methods. Christopher McGrath (Ph.D., '96) contributed an additional weapon to our spectroscopic arsenal with his development of the gamma-gamma coincidence method with these fast neutrons. Minfang Yeh (Ph.D., '97) and Mohammad Kadi (Ph.D., '98) employed all of these methods to evaluate measurements in our laboratory to new heights and to address questions, such as the existence of multiple octupole oscillations, at previously inaccessible levels of sensitivity. Several postdoctoral fellows have also made valuable contributions to our program. It has been a pleasure to work with these fine scientists.

EDUCATION NEWS

Two members of the Department have been recognized for their contribution to the educational mission of the University. Mark Meier was named one of the "Top 10 Professors" in the College of Arts & Sciences. This award is especially meritorious in that the graduating seniors select these ten individuals in a vote by answering the question "which professor made the largest contribution to your undergraduate career." Dave Robertson was selected to receive the Chancellor's "Outstanding Teaching Award for Tenured Faculty." The competition for this award spans several colleges and Dave is simply grateful to "be part of the group considered for the award."

Allan Butterfield received the "Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring" at a ceremony in the Oval Office of the White House. The award, which is given to ten individuals each year, originates in the White House Office of Science and Technology Policy and is administered by the National Science Foundation. Allan was nominated for this award because of "the large number of female graduate students for whom he has served a preceptor and because of the large number of students from Appalachia who have participated in research in his group." Art Cammers-Goodwin has also received national recognition for his efforts in education. He was recently appointed to the Chemistry Technology Board Committee of the Division of Chemical Education of the American Chemical Society.

Bob Grossman's text, "The Art of Writing Reasonable Organic Reaction Mechanisms," was published by Springer this year. The text is receiving praise from faculty around the world and an anonymous review of the book from a former student of Bob's can be found on amazon.com. "Great book. There are good problems at the end of each chapter to help reinforce what you have read. He uses words that are easy to understand, which makes the reading of the book more enjoyable."

"Holy Plutonium, Batman – We're in a Chemistry Class!"

The new, improved Periodic Table of Comic Books can be viewed on the World-Wide Web at http://www.uky.edu/Projects/Chemcomics/. The site, developed by Jim Holler and Jack Selegue, is one of the most popular stops on the UK web server. The original version surpassed 300,000 hits on its home page in January 2000. Version 2.000 went on-line on February 13, 2000, and it promises to become even more popular. The site features a Periodic Table with hyperlinks to images from comic books that feature characters or plots based on the chemical elements. Characters from Superman to Donald Duck to Ricky Nelson can be found on the site. Traffic is especially heavy from U. S. education institutions. Chemistry teachers at all levels have used the site to interest their students in chemistry. The site has received many awards, including selection as a Yahoo! Pick of the Week, World Village Family Site of the Day and a USA Today Hot Site. Media as diverse as the New York Times, Yahoo Internet Life, the London Daily Telegraph, Science, Chemical Week and Physics Today have published articles about the site. Based on feedback from web browsers, the site is sparking an increased awareness in chemistry among children of all ages by making the subject seem less intimidating to the public.

IGERT Fellowship Program

A new multiyear Ph.D. Fellowship program was established in our department in the fall of 1998. This resulted from funding of a proposal that was submitted to the Integrative Graduate Education and Research Training (IGERT) Program of the National Science

Foundation. UK's Proposal was one of only 17 funded nationwide by the NSF, and was chosen from among 626 submitted proposals.

The IGERT Program provides fellowships to students interested in the science and engineering of sensors and sensing architectures. This program is directed by Professor Leonidas G. Bachas of our department. Other faculty participants are Arthur Cammers-Goodwin, Sylvia Daunert and Robert Lodder from Chemistry; Kimberly W. Anderson and Dibakar Bhattacharyya from the Department of Chemical and Materials Engineering; and Craig Grimes and Janet Lumpp from the Department of Electrical Engineering.

The IGERT Program has established a cross-disciplinary doctoral program in science and engineering using state-of-the-art equipment and facilities. Graduate students participating in the IGERT Program receive their Ph.D. degree in one of these departments and benefit from a host of cross-disciplinary education and research activities in sensors and related technologies. The research program is focused around five different multi-disciplinary themes that integrate principles from two or more of the following areas: analytical chemistry, organic synthesis, molecular recognition, signal processing, materials, chemical engineering, bioengineering, remote sensing, micro-fabrication, and molecular biology.

The IGERT Fellowship is worth about $25,000 per year. This is a multi-year fellowship that includes tuition, a great stipend, paid travel to conferences, as well as allotments for books and supplies. There are 15 fellowships available each year. You can find out more about this Fellowship Program by visiting the IGERT web page at: http://caribe.chem.uky.edu/sensors/sensoshome.html.

NEWS FROM THE DIRECTOR OF GRADUATE STUDIES, BOB GUTHRIE

The Chemistry Department owes a great debt of gratitude to Jack Selegue and Carol Brock for strengthening our graduate program during difficult times. I took over the DGS job in July, 1999, and have spent a lot of the fall learning new rules and making mistakes. After early stumbling through the forest of bureaucratic complexities, I am gradually emerging onto the real battlefield, recruitment of a graduate student body to match the growing talent of our faculty. Confronting this main challenge, I find my self torn between excitement about our prospects and concern about our problems.

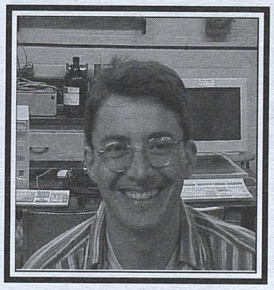
The excitement is created by the prosperity of our Department. Research groups are bringing in more grant dollars than ever before. The research emphasis of the Department is leaning more toward biologically related chemistry while maintaining strength in more traditional disciplines. Across the Department, research funding is as high as it has ever been. The exciting aspect of this developing wealth is that graduate students are moving in greater numbers and at earlier stages in their tenures to grant-supported research assistantships. This means that students should be able to start dissertation work earlier, devote a more intensely concentrated effort and finish sooner with a higher quality product. The problematic part is that the same burgeoning economy which is bringing research support is simultaneously offering more career alternatives to college graduates. As a result, the number of qualified U. S. - educated students applying to the graduate program has decreased steadily over the past several years. To be sure, there is still an abundance of applications from highly-qualified international students and I plan to continue to make a significant number of offers to these individuals. In my opinion, our international contingent provides indispensable enrichment to our program. On the other hand, it is important to maintain balance and in an effort to increase the attractiveness of graduate study, I have put forward what I consider to be highly lucrative financial offers to the best domestic candidates. With tuition remission thrown in, it is now possible to obtain a Ph.D. in chemistry, maintain a comfortable lifestyle and probably start a savings account at the same time. In fact, if all of the offers I have made for next fall were to be accepted, we would have trouble buying paper clips next year.

In reading application letters, I am becoming aware that the research reputation of our faculty is spreading. I now see letters that say "my advisor at The University of X says that Kentucky has an excellent program in Y and Professor Z would make an outstanding mentor." That, and money, is what it will take. We'll give it our best shot!

FROM THE X-RAY LAB

Spring 1998 brought major changes to the X-ray lab: the reliable CAD4 single-crystal diffractometer purchased in 1976 was replaced with a new state-of-the-art Nonius Kappa-CCD instrument. The new diffractometer collects data at least 30 times faster than its predecessor; data collection times are now measured in hours rather than in days. The increase in sensitivity allows data to be measured for crystals that scatter X-rays weakly and we have successfully refined several structures that could not even be solved with data from a conventional diffractometer. One such structure is of a fullerene derivative synthesized by Mark Meier's group. Reaction of dichlorocarbene with C_{70} gives one isomer that is the product of $:CCl_2$ addition across a 5-6 ring junction. The addition reaction breaks one of the bonds of the fullerene cage. The structure of the reaction product is the first structure of a fullerene with an "open" bond. The C-C distance for that non-bond is 2.14 Å, i.e., 0.7 Å longer than the bonded distance.

The increasing research activity in the Department coupled with such a powerful instrument requires the undivided attention of an expert. During the first year that person was Brian Patrick, a Postdoctoral Fellow from the University of British Columbia. In 11 months Brian measured about 160 data sets, solved and refined well over 100 different structures, and developed standard operating procedures for the lab. At the end of March 1999 Brian went back to Vancouver, where he is now the UBC staff crystallographer. The Department's campaign to convince the University Administration that it was crucial to replace Brian with a regular staff member in a continuing position was successful and the position is now filled by Dr. Sean Parkin. We very much appreciate the University's support of the X-ray lab.



Dr. Sean Parkin. Sean arrived at the end of February 2000 to take over responsibility for the X-Ray Laboratory. Originally from England, Sean did his Ph.D. work at the University of California at Davis with Hakon Hope. Since then he has held Postdoctoral/Scientist positions at Lawrence Livermore National Laboratory and Duke University Medical Center. Sean has extensive experience in both small-molecule and protein crystallography, a combination that is especially appropriate given the Department's expansion into Biological Chemistry. Sean's wife Stephanie grew up in Georgetown, so a move to Lexington means nearby grandparents for their two small children.

BIG STEPS FORWARD IN THE NMR LAB

Over the last 8 months there has been an unprecedented transformation in the Department's NMR facility. With funds from the State Bond Issue, the Research Challenge Trust Fund, and two grants from the National Science Foundation, our facility has been transformed from a 3-instrument shop into a 6-instrument facility. Our two 200 MHz Gemini instruments are still being used, but the 1980 vintage Varian VXR-400 has been upgraded to a modern Varian INOVA in-

strument, with electronics that are vastly superior to the older model. This instrument is joined by a new 400 MHz INOVA instrument, and a new 600 MHz INOVA. The 600 MHz instrument is state-of-the-art, with 4 rf channels, 40 room temperature shims, and an actively shielded magnet that gives it a smaller footprint than the non-shielded 400 MHz magnets. Still to come is a 400 MHz wide-bore instrument for solid samples.

The old NMR lab could not house this new suite of instruments. The back half of the stockroom has been walled off and converted into a new NMR lab, providing space for all six instruments, plus a data station. The work is not finished - installation of instruments is still underway and some aspects of construction are incomplete, but nevertheless the new laboratory is an impressive site. Stop by for a tour!

NEWS FROM FACULTY AND STAFF

Leonidas G. Bachas: Leonidas was invited to give a research presentation in a workshop organized by NASA and the Center for Emerging Cardiovascular Technologies on the research of his group in the subject of biocompatible sensors. He also gave invited talks at PITTCON'98 in March 1998 on the "Rational Design of Ionophores for Anion-Selective Electrodes," at the ACS National Meeting in Boston in August 1998 on "Site-Directed Immobilization of Proteins on Surfaces," at PITTCON'99 on "Mercuracarborand Based Liquid/Polymeric Membrane Electrodes," at the ACS National Meeting in Anaheim in April 1999 on the "Design of Recognition Elements for Environmental Ion Sensors," at the 1999 Spring Meeting of the Materials Research Society on "Ordered Assembly of Proteins on Surfaces," and at the 1999 Biomedical Engineering Society Meeting. His work was presented at a Gordon Conference in 1999 and he was a plenary speaker at the XIII Senior Technical Meeting in Humacao, Puerto Rico. Leonidas served as the Chair for the Lexington Section of the American Chemical Society for 1998. In December, he visited Spain where he collaborates with research groups at the Autonomous University of Barcelona, the University of Girona, and the University of Tarragona. Professor Bachas is the Director of a new fellowship program in our department that is funded by the Integrative Graduate Education and Research Training (IGERT) initiative of the National Science Foundation (see elsewhere in the Newsletter for a description of this program.)

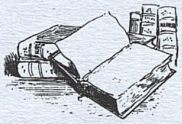
Carol Brock: Carol has been very busy all year with the new CCD diffractometer. The instrument was purchased and installed, and a postdoc was hired to run it. There were computers to be networked, and new software and a new operating system to be learned. Two weeks after installation began the lab was turning out structures at the rate of 4-5 per week, a surprising number of which turned out to be very interesting to crystallographers and solid-state chemists. It is a busy and exciting time. Carol's other activities included a week in Malaysia in October as an invited speaker at the meeting of the Asian Crystallographic Association and a week in England in February spent visiting the Cambridge Crystallographic Data Centre. The trip to England also included a day with colleagues in Oxford, who provided lodging and an elegant dinner in one of the oldest colleges.

Maggie Johnson: Maggie was elected as Secretary of the American Chemical Society's Division of Chemical Information. She is very active in the Division's Education Committee and will be teaching with committee members a three-hour workshop at the Biennial Conference on Chemical Education in Ann Arbor in August, 2000, on "Teaching Chemical Information: Introduction and Practice." In December, 1999, Maggie, with Eric Grulke, published a chapter titled "Database Searching for Polymer Literature," in the *Polymer Handbook*, 4th Edition, John Wiley & Sons, Inc., New York, 1999. When not teaching, writing, or answering reference questions, Maggie and her husband, Terry, spend time on their houseboat "Equilibrium" at Lake Cumberland. Terry often fishes from their runabout "Free Radical." As you might guess, Terry is also involved in chemistry and is Director of Metabolism and Residue Chemistry at The Pharmalogical and Toxicology Research Laboratory of Richmond, KY.

Jack Selegue: The year 1999 was a transitional one for Jack. He completed his fourth and final year as Director of Graduate Studies, Associate Chair of Chemistry and Principal Investigator of a multidisciplinary NSF-EPSCoR project on "Carbon-Based Materials." His research group dwindled with the distractions of administrative work, consisting now of graduate students David Eaton (joint with John Anthony) and Aaron Tomasek, plus three excellent, new undergraduates. Al Carrillo, Aibing Xia, Chad Wallace and Mark Blankenbuehler all finished their degrees since the last newsletter. His group continues to work on organometallic chemistry and fullerenes, with a growing interest in carbon nanotubes and organic materials. Jack's group has a field-flow fractionation system up and running for the separation and analysis of small particles, initially looking at carbon nanotubes and soot. Jack and his students gave presentations at many meetings, including the Gordon Research Conference on Organometallic Chemistry in Newport, RI, and ACS National Meetings in Boston and Anaheim, and a meeting of the Electrochemical Society in Seattle. Jack is still a member of the committee of Examiners for the GRE Chemistry Examination. Jim Holler and Jack continue to present their annual Reaction Attraction demonstrations for local grade school students in the spring.

Edith, Jack's wife, is working in the Morris Library of the Gluck Equine Research Center at UK. Their son Paul is in the magnet program at Winburn Middle School. Their 1998 travels were less ambitious than usual, just visiting their families in Wisconsin and Ohio, while 1999 took them to Yellowstone National Park and the surrounding Idaho-Montana area.

Steve Yates: In December, 1998, Linda and Steve returned from their second six-month stint in Los Alamos, NM, where Steve was working at Los Alamos National Laboratory and Linda spent much of her time exploring the mesas and canyons of Northern New Mexico. Their daughter, Michelle Lynne Childers, and her husband made Steve and Linda grandparents for the first time; Brittany Ann Childers was born on March 12, 1999. Steve continues to serve in a number of capacities in national and international organizations. He recently participated in a National Science Foundation Review Panel and was appointed to the Commission on Radiochemistry and Nuclear Techniques of the International Union of Pure and Applied Chemistry. He is now in his second term as councilor of the ACS Division of Nuclear Chemistry and Technology and was recently elected to the ACS Committee on Science. In addition, he was recently appointed to the Board on Chemical Science and Technology of the National Research Council.



NEWS FROM THE CHEMISTRY-PHYSICS LIBRARY, MAGGIE JOHNSON

Why do we need a chemistry library? Information is available on the web these days.

Yes, there are many good information resources on the Web and even some in chemistry. The National Institute of Standards (http://webbook.nist.gov/), ACS's ChemCenter (http://www.acs.org/) and ChemExpo (http://www.chemexpo.com/) all provide information and pointers to other useful chemistry sites. This free information can answer questions about companies addresses, chemical availability, and the spectra of very common compounds. But, for real

chemical research, the journal literature is still the primary source of information. For this data, someone must pay. It is often the library.

The University of Kentucky Science/Engineering Libraries (of which Chemistry is one) spend over 1.9 million dollars per year on books, journals, indexes, and electronic products. The goal of the Science/Engineering Libraries is to deliver as much information as possible to the scientists desktop electronically. The publishing world is in a state of flux and in many cases we must purchase paper copies and pay a surcharge for electronic access. The electronic access is provided seamlessly to UK users because the vendors recognize UK computer addresses and know the library has paid. Thus, it looks free to the UK user and the bill comes to the library.

Examples of electronic products we have added in the last two years are Web of Science (the old Science Citation Index), SciFinderScholar (Chemical Abstracts), ScienceDirect (full text of all journals published by Elsevier), Analytical Abstracts database, Wiley-Interscience (journals published by Wiley full-text), and the suite of Cambridge Scientific Databases.

Our goal that a scientist or student will sit at her desk, type an information request into a database online, get back a list of articles that are of interest, then click to see the entire article. She could then just click to email the author, find more articles, or look at experimental data. The role of the library would be to evaluate which databases and journals to purchase online, train students in the use of the new electronic information, evaluate searches and answers to ensure they fulfill user needs, and figure out how to warehouse all the old paper products. Think this day is far away? It's not. We are already 75% there.

The next time you visit UK stop by the Chemistry Library to see all the exciting new information we have available. But, don't worry, we'll still check out books to you.

GRADUATE DEGREES AWARDED

Doctor of Philosophy

Lori Jean Blanchard (Robertson) August 97, "Development and Application of Nuclear Methods for the Analysis of Mercury and Other Elements in Coal," Postdoctoral Fellow (1 year), Westinghouse Savannah River Company, Aiken, SC.

Mark Thomas Blankenbuehler (Selegue) December 99, "Approaches to Organometallic-Fused Heterocycles," Assistant Professor, Morehead State University, Morehead, KY.

Warren William Harper (Clouthier) May 98, "High-Resolution Jet Spectroscopy and Dynamics of Semiconductor Growth Intermediates," Postdoctoral Fellow, Department of Chemistry, University of Colorado, Boulder, CO.

Emily C. Hernandez (Bachas) December 97, "Development of Biosensors and Binding Assays Using Molecular Recognition Systems," Scientist I, Magellan Laboratory, Durham, NC.

Wei Huang (Bachas) August 97, "Genetic and Chemical Modification of Proteins for Site-Specific Immobilization and Binding Assays," Exxon Chemical, Baton Rouge, LA.

Mohammad W. A. Kadi (Yates) December 98, "A Study of the Nuclear Structure of ^{207}Pb and ^{116}Cd with the (n,n'γ) Reaction," Assistant Professor, King Abdul Aziz University, Jeddah, Saudi Arabia.

Tanuja Anand Koppal (Butterfield) December 98, "Amyloid β-Peptide- and Peroxynitrite-Induced Oxidative Stress in Rodent Cortical Synaptosomal Membranes: Insights Into Neurotoxicity in Alzheimer's Disease Brain," Northwestern University Medical School, Chicago, IL.

Julie Helen Kuhr (Robertson) May 98, "Application of Low-Rank Coal for Removal of Heavy Metal and Radioactive Contaminants from Aqueous Solutions," Analytical Services, Exxon, Baton Rouge, LA.

Jennifer C. Lewis (Daunert) August 99, "Naturally Occurring Luminescent Proteins as Labels in the Development of Binding Assays for Small Biomolecules," Senior Scientist, Pfizer, Groton, CT.

Sridhar Ramanathan (Daunert) December 97, "Genetically Engineered Bioluminescent Systems in Analytical Chemistry," Director Analytical Chemistry Labs, General Electric, Bangalore, India.

Linda L. Rulon (Robertson) December 99, "Atomic Absorption Spectroscopy, A) Graphite Surface Treatments and Their Effects, B) Serum Zinc Concentrations and Alzheimer's Disease," working on finding employment, Lexington, KY.

Vesna Schauer-Vukasinovic (Daunert) May 98, "Design of Bioseparation and Biosensing Systems Based on Protein Conformational Changes," Senior Scientist, Hoffman-LaRoche, Basal, Switzerland.

Melissa Anne Varner (Grossman /Guthrie) December 99, "A Novel Double Annulation Route to *Trans*-Decalins," Affinity Labelling Technologies, Lexington, KY

Chad Everett Wallace (Selegue) December 98, "The Synthesis, Characterization, and Reactivity of Some Ruthenocene-Fused Heterocycles," Assistant Professor, Asbury College, Wilmore, KY.

Jianquan Wang (Bachas/Daunert) December 99, "Genetically Engineered Proteins in the Development of Immunoassays and Site-Directed Protein Immobilization," Postdoctoral Fellow, Department of Chemistry, University of Kentucky, Lexington, KY.

Yuguo Wang (Davis/Guthrie) August 99, "Dehydrocyclization by Platinum Monofunctional Catalysts," Center for Applied Energy Research, Lexington, KY.

Brad R. Weedon (Meier) May 99, "The Zn/Cu Reduction of C_{60}, C_{70}, and the Homofullerene, $C_{61}H_2$: A Facile Method for the Synthesis of Reduced Fullerenes," The Goodyear Tire Rubber Company Corporation, Akron, OH.

Aibing Xia (Selegue) May 98, "Studies in Organoruthenium Chemistry: π-Complexes with Curved Hydrocarbons and σ-Thienylacetylides," Postdoctoral Fellow, Department of Chemistry, University of Missouri, Columbia, MO.

Servet Makar Yatin (Butterfield) August 99, "*In Vitro* and *In Vivo* Free Radical Oxidative Stress Associated with Alzheimer's Disease Amyloid β-Peptide," Harvard Medical School, Boston, MA.

Master of Science

J. Christopher Ball (Bachas) August 97, "Ion-Selective Electrodes for Sodium and Ibuprofen," Ph.D. Program, Department of Chemistry, University of Kentucky, Lexington, KY.

Marsha Cole Ball (Butterfield) December 98, "The Effects of Antioxidants on Membrane Proteins in Oxidative Stress Systems," Graduate School, Nutritional Science, University of Kentucky, Lexington, KY.

Chaoxian Cai (Davis) December 98, "Mechanism Studies on Homogeneous Water Gas Shift Reaction."

Alberto Carrillo (Selegue/Brock) May 98, "Crystallographic Studies of Potentially Trigonal Organic Salts and Some Group 8 Organometallic Compounds," Lexmark Corporation, Lexington, KY.

Todd Fields (Guthrie) May 99, "Aromatic Hydrogenation Catalyzed by Thermally Activated Silica," Union Carbide, South Charleston, WV.

Eric J. Hawrelak (Ladipo/Selegue) December 98, "Synthesis of Tris(Dimethylsilanyl)methyllithium: Reactivity with Organosilicon Compounds," Graduate School, Department of Chemistry, Virginia Tech, Blacksburg, VA.

Yue Liu (Daunert) August 99, "Evaluation of Reporter Genes in Bacteria-Based Biosensing Systems for Heavy Metal Ion and Oxyanion Detection."

David Starling MacMillan (Toreki) December 98, Non-Thesis, Lexmark, Lexington, KY.

Jignaben D. Patel (Daunert) May 99, "Reversible Immobilization of Enzymes on Membranes Based on a Calmodulin Fusion Tail," College of Pharmacy, University of Kentucky, Lexington, KY.

Shawn Leigh Plummer (Bachas) August 97, "New Potentially Useful Ionophores for Ion-Selective Electrodes," Senior Scientist, Inorganic Analysis Branch, Kentucky State Department of Environmental Protection, Frankfort, KY.

Chava Bader Pocernich (Butterfield) August 99, "Free Radical Oxidative Stress in Rat Brain: Insights into the Cholinergic Deficit Hypothesis of Alzheimer's Disease and Protection by *In-Vivo* Elevation of Glutathione," Graduate School, Department of Chemistry, University of Kentucky, Lexington, KY.

William Hardwick Sewell, III (Selegue) May 98, Non-thesis, Chemist/Scientist I, Federal Facilities Oversight Unit, Kentucky Water Resources Research Institute, University of Kentucky, Lexington, KY.

Gargi Sur (Daunert) December 99, "Production and Purification of Recombinant Peptides/Proteins from Transgenic Tobacco Plants."

Chaohui Tong (Toreki) August 98, "Construction of Zinc-Carboxylate Nanoporous Materials."

Robert Jason Trupp (Grossman) December 98, "Asymmetric Halocyclization: Synthesis of Artificial Sources of Chiral Halonium Ion," Cleaning Validation Chemist, International Processing Corporation, Winchester, KY.

Jennifer Ann Wininger (Daunert) December 98, "Preparation of an Aequorin-Peptide Conjugate by Gene Fusion for Use in the Development of an Immunoassay for the Peptide."

Zhiren Xia (Bachas) August 98, "Design, Synthesis and Evaluation of a New Ionophore for Potassium."

STUDENT AWARDS

UNDERGRADUATE AWARDS

Willard Riggs Meredith Award to the outstanding senior in Chemistry. 1998: **Steven Stogner**; 1999: **Lori A. Watson**; 2000: **Mark Andrew Thoma**.

Charles Hammond Undergraduate Service Award for outstanding service to the department. 1998: **D. Harold Rosenbaum** and **Lori A. Watson**; 1999: **D. Harold Rosenbaum**; 2000: **Michelle Lee Whitt**.

Merck Index Award for scholastic achievement in chemistry. 1998: **Shane Foister**; 1999: **Adam Breier**; 2000: **Jimmye Shannon Perkins**.

Undergraduate Award in Analytical Chemistry for displaying an aptitude for a career in analytical chemistry. 1998: **Jason Shergur**; 1999: **Mark Thoma**; 2000: **Mark Walker Amick**.

American Institute of Chemists Award for scholastic achievement, leadership ability, and character. 1998: **Christopher Borths**; 1999: **Aaron Skaggs**; 2000: **Kathleen Marie Clark**.

Freshman Chemistry Achievement Award to a first-year chemistry major with a record of outstanding academic achievement in chemistry. 1998: **Christopher A. Bradley** and **Janna M. Hackett**; 1999: **Alisha O'Connell** and **Joshua Shofner**; 2000: **Christopher Chase Reynolds**.

Hammond "Excellence in Chemistry" Competition Award. 1998: **Adam Breier** (1st), **Shane Foister** (2nd), **Aaron Skaggs** (3rd); 1999: **Michelle Dudley**; 2000: **Christopher Arch Bradley** (1st), **Mark Allen Wurth** (2nd), **Janna Marie Hackett** (3rd).

Stephen Harris Cook Undergraduate Summer Research Fellowship. 1998: **Aaron Skaggs**; 1999: **Reuben Maggard**; 2000: **Jesse Wayne Tye**.

General Chemistry Excellence Award to the student with the highest score in general chemistry each semester. **Logan Elliott Turner** (Spring 1998); **Ryan A. Chilton**, **Ilaaf Darrat**, **Courtney L. Reynolds**, **Joshua A. Sheffel**, and **Kris C. Wood** (Fall 1998); **Ilaaf Darrat** and **Adam Wesley Kays** (Spring 1999); **Lauren Ashley Baldwin**, **Tiffany Jo DeWeese**, **Key Covington Douthitt**, and **Amy Elizabeth Sandman** (Fall 1999).

Thomas B. Nantz Memorial Scholarship; tuition scholarship. 1998-1999: **Michelle Dudley**, **Jessica Morgan**, **D. Harold Rosenbaum**, and **Aaron Skaggs**; 1999-2000: **Reuben Maggard**, **Michelle Dudley**, and **Adrienne Nicole Ellis**; 2000-2001: **Alisha Marie O'Connell**, **Diane Elizabeth Schmall**, and **Maria Elizabeth Tsoras**.

Wilbur L. Price Memorial Scholarship. 1998-1999: **James Pennington** and **April Perry**; 1999-2000: **Whitney Dawn Bramblett** and **Alison McKenzie Mirick**.

Dr. Hume and Ellen Towle Bedford Scholarship. 2000-2001: **Adrienne Nicole Ellis**.

David W. and Eloise C. Young Scholarship. 2000-2001: **Christina Dawn Brown**.

GRADUATE AWARDS

Departmental and University Awards

Franklin E. Tuttle Fellowships. 1998-1999: **Robert G. Bergosh**, **Jessika S. Feliciano-Cardona**, **Aaron R. Hutchison**, **Jeffrey L. Schwarz**, and **Aaron J. Tomasek**; 1999-2000: **Robert G. Bergosh**, **Jessika S. Feliciano-Cardona**, **Aaron R. Hutchison**, **Jeffrey L. Schwartz**, and **Aaron J. Tomasek**.

Paul I. Murrill Fellowships. 1998-1999: **Jeffrey Lenihan** and **Brad Weedon**; 1999-2000: **Rashada C. Alexander** and **Jeffrey S. Lenihan**.

Graduate School Lyman T. Johnson Minority Fellowship. 1998-1999: **Marlon Jones** and **Thea Williams**.

Graduate School Allocated Academic Year Fellowships. 1998-1999: **Melissa Varner**, **Jianquan Wang** (declined for Research Challenge Trust Fund), and **Oleg Ozerov**.

Graduate School Quality Achievement Fellowship. 1998-1999: **Jeffrey Lenihan**.

Behrman Fund Awards

Charles H. H. Griffith Outstanding General Chemistry Teaching Assistant Award. 1998-1999: **Jeffrey L. Schwarz**; 1999-2000: **Jason Shergur** and **D. Harold Rosenbaum**.

Outstanding Teaching Assistant Award. 1998-1999: **Mark T. Blankenbuehler** and **K. Michael Hardy**; 1999-2000: **Ramesh B. Iyer**.

Fast Start Award to the graduate student in their first or second year in the Department of Chemistry, who has made outstanding initial overall progress towards their degree. 1998-1999: **David L. Eaton**; 1999-2000: **Hui Hu**.

Outstanding Research Award based on research accomplishments for the past year. 1998-1999: **Tanuja Koppal** and **Servet Yatin**; 1999-2000: **Brad R. Weedon**.

100% Plus Award to the student who shows the most exemplary professional attitude. 1998-1999: **Robert G. Bergosh** and **Melissa A. Varner**; 1999-2000: **David L. Eaton**.

Kentucky Research Challenge Fellowships:

1999: **David L. Eaton**, **Aaron R. Hutchison**, and **Libby G. Puckett-Sparks**.

Research Challenge Trust Fund Fellowships:

1999: **Maria J. Berrocal**, **Sapna K. Deo**, **Yi He**, **Krishnamoorthy Kuppannan**, **Hormuzd R. Mulla**, **Lyndon L. E. Salins**, **Jianquan Wang**, and **Servet M. Yatin**.

TORA (Target of Opportunity Research Award):

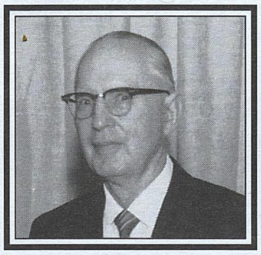
Tuition scholarships for research assistant. 1999: **Daniel M. Bowles**, **Mark A. Hamon**, **Dell W. Jensen, Jr.**, **Christopher M. Lauderback**, **Marlon D. Jones**, **Jaroslaw Kanski**, **Grant J. Palmer**, **Suresh Shrestha**, and **Tony C. Smith**.

External Awards

National Science Foundation Graduate Fellowship. 1999: **Jessika S. Feliciano-Cardona.**

National Science Foundation - IGERT (Integrative Graduate Education and Research Training) Fellowship. 1999: **Kalvin J. Gregory**, **Robert D. Johnson**, **Jennifer C. Lewis** and **Peter Willis**.

The 2000 Dawson Lecture



One of the highlights of the fall semester at UK is the Lyle Dawson Lecture. This annual lecture, supported by Professor Dawson's family, commemorates His leadership in the Department and features speakers noted for the quality, depth, and breadth of their research. Recent Dawson Lecturers have included Professors Frederick Hawthorne of UCLA, Julius Rebek of Scripps Research Institute, and Richard Zare of Stanford. We are pleased that Professor Robert H. Grubbs, the Victor and Elizabeth Atkins Professor of Chemistry at California Institute of Technology, will present the 2000 Dawson Lecture on November 17. Additional information about the Dawson Lecture can be found at the Departmental Web site (www.chem.uky.edu).

Annual Symposium on CHEMISTRY AND MOLECULAR BIOLOGY established in memory of Anna S. Naff

As noted in the Chairman's message, the Department of Chemistry organizes an annual Symposium on Chemistry and Molecular Biology. This symposium was established in honor of Anna S. Naff, a University of Kentucky graduate, through the generous support of Dr. Benton Naff. The Symposium has an interdisciplinary character and is attended by students and faculty from Chemistry, Engineering, Biology, Biochemistry, Pharmacy, and Medicine. The Symposium is also attended by faculty and students from colleges and universities in Kentucky and the contiguous states.

Throughout the first twenty-five years, many outstanding scientists have presented their research at these Symposia. The twenty-sixth Naff Symposium was held Friday, April 7, 2000 on the topic of *NMR Spectroscopy in Biological Chemistry*. Featured speakers included Professor Ad Bax, Professor Stanley Opella, Professor Michael Summers, and Professor David Wemmer. Detailed information about these Symposia is available at http://www.chem.uky.edu/seminars/naff/welcome.html.

NAFF SYMPOSIUM 5-YEAR EXPENSE REPORT 1995-1999

EXPENSES	**1995**	**1996**	**1997**	**1998**	**1999**
Honoraria	$5,000	$6,000	$4,000	$3,000	$4,000
Seminar Expenses	0	157	945	2,127	2,944
Dinners	391	535	792	840	1,125
Refreshments	327	458	281	322	558
Brochure Printing	407	492	164	316	744
Buffet	302	704	863	614	743
Postage	100	100	130	227	124
Flowers	93	210	25	0	130
General Supplies	0	0	0	200	0
Student Help	0	120	120	180	0
Total Expenses	6,620	8,776	7,320	7,826	10,368
Earned Income	9,766	9,731	10,036	11,088	10,178

Endowment Reserve as of May 27, 1999 $110,410

Editors: Steven W. Yates and J. David Robertson
Editorial Assistant: June Smith

CONTRIBUTIONS TO THE DEPARTMENT OF CHEMISTRY OF THE UNIVERSITY OF KENTUCKY

If you would like to make a gift to the University of Kentucky Department of Chemistry, please indicate how you would like your contribution applied.

☐ **University of Kentucky Chemistry Endowment Fund** – Income (typically 5% annually) is used for graduate research and undergraduate summer research assistantships.

☐ **Chemistry Development Fund** – Funds are used for the benefit of the Chemistry Department at the discretion of the Chairman.

☐ **Paul L. Corio Scholarship Fund** – This new scholarship fund is being established in memory of Professor Corio, who passed away in 1997.

☐ Please contact me to discuss my gift.

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