

CENTER FOR NANOSCIENCE
UNIVERSITY OF MISSOURI-ST. LOUIS

Self-Study Report
(September 2006 to April 2008)

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Prepared By

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Center for Nanoscience at the University of Missouri-St. Louis
An interdisciplinary research center focusing on collaborative science and technology and serving the regional communities

Mission, Vision, and Strategy

The *mission* of the Center for Nanoscience (CNS) at the University of Missouri-St. Louis is to serve as a nexus for fundamental interdisciplinary research and to elevate the research capacity of our faculty and students for cutting-edge research, technology transfer, cooperative and educational outreach and workforce development.

Our *vision* is to advance nanoscale science and technology to improve the quality of life and to be a powerful engine driving the economic growth of the Greater St. Louis Region.

Our *strategy* is to attract scientists and students from diverse backgrounds to the study of nanoscale phenomena and to develop novel technologies. The current focus of Center efforts is in the areas generally encompassed by energy, food, health and environment. Center members focus on fundamental research with a clear goal to translate breakthrough discoveries into practical applications. The Center works closely with local industries and other scientific communities to enhance scientific activities, to develop novel technologies, and to train capable scientists.

The CNS mission and vision integrate with and support the University's mission by providing "technologies and partnerships that link UMSL to communities, institutions, and businesses regionally, nationally and internationally." The CNS provides students the opportunity to learn multidisciplinary research, to interact with industrial scientists, and to work on interdisciplinary research projects that affect the St. Louis region and beyond. The Center's programs are designed to focus on the needs of local communities and to be in synergy with the development of local industries in such critical interdisciplinary areas as energy, environment, food and health. By attracting researchers and students from different disciplines, the Center expects to develop collaborations on new and broad scientific fronts and to foster highly visible translational research.

Staff and Physical Plant

The CNS is housed in the William L. Clay (WLC) Building, which has available 11,300 square feet for research laboratories, 2,700 square feet for research support space (*e.g.* offices for CNS members), and a modern conference room. The centralized Microscopy Image and Spectroscopy Technology (MIST) Lab and the X-ray Diffraction Facility are located in the WLC building. CNS currently consists of 15 faculty members (with home departments in the Department of Chemistry and Biochemistry and Department of Physics and Astronomy), two research professors and three staff members.

The CNS evolved from the original Center for Molecular Electronics (CME), which was established in 1997 (see appendix A for background information on CME). In March 2007, the CME was renamed to the CNS. This was done in order to encompass the range of research activities both within the William L. Clay building *per se* and by Center members working in adjacent laboratories. The name change, which was approved by all CNS stakeholders, also embraces the future focus of the Center's research programs. The key goal of the renamed Center for Nanoscience is to become a center of excellence in interdisciplinary research. Following extensive organizational and administrative changes made during the preceding 12 months, the CNS held a very successful open house in October 2007 to introduce the newly named and reorganized Center (see appendix B for details).

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The Center for Nanoscience meets all the definitions of a center as defined in the *UM Collected Rules* Chapter 50 criteria.

University Involvement and Current Organization

During the Fall of 2006, Drs. Jingyue (Jimmy) Liu and George Gokel joined the UM – St. Louis faculty as Director and Associate Director, respectively, of the Center for Molecular Electronics. Dr. Liu was previously a Senior Science Fellow and Senior Research Manager of Monsanto Company and Dr. George Gokel was a Professor of Chemical Biology and Program Director of Chemical Biology at the Washington University School of Medicine. Dr. Jimmy Liu has worked in nanoscience broadly defined for more than 20 years and has acquired broad knowledge in physics, chemistry, and biology (see appendix C for full CV). Dr. Liu's broad scientific background, extensive experience in managing diverse research groups, and strong connections with industry leaders make him the ideal candidate to facilitate establishing the future directions of the Center in research, coordinating internal and external collaborations and enhancing the Center's translational research activities. Dr. George Gokel is a well-established scholar with over 400 peer reviewed publications and over 300 invited lectures at national/international conferences, has an excellent track record of attracting federal funding, and is highly respected in the academic community (see appendix D for full CV). Dr. George Gokel focuses on significantly enhancing the Center's capability of obtaining competitive federal funding.

Dr. Liu and Dr. Gokel complement each other scientifically and administratively. Their leadership has already transformed the CNS (previously CME) from an almost non-interactive collection of scholars to a dynamic, vibrant and integrated research center. Numerous changes have been made to foster faculty interactions within the Center (see appendix E for recent initiatives and accomplishments). These initiatives have extended to scholars in other departments in the hope of expanding interactive and collaborative efforts. We believe that the Center for Nanoscience is on track to achieve its goal as a center of excellence in nanoscale science and technology.

The initial scholarly effort asked CNS members to define research areas of interest. These were then refined into research thrust areas with the approval of CNS members. Center members then aligned themselves with one or more of the research clusters with a goal of interacting, collaborating, and developing novel coordinated research efforts. These member-approved research platforms have formed the basis for scientific interactions, strategic research programs, and joint grant proposals. The research platforms are described briefly below and those faculty members allied with each are identified.

Nanoscale Materials & Systems

Members: Peter Handel (Professor of Physics), Jimmy Liu (Professor of Physics and Chemistry), Eric Majzoub (Assistant Professor of Physics), Mike Nichols (Assistant Professor of Biochemistry), James O'Brien (Professor of Chemistry), Keith Stine (Associate Professor of Chemistry), Janet Wilking (Assistant Professor of Chemistry). *Cluster Leader: Keith Stine*

This research platform focuses on synthesizing nanoscale materials and systems and testing their physical, chemical or biological properties for broad applications in energy, biology, and biotechnology.

Membrane & Cellular Function

Members: James Bashkin (Research Professor of Chemistry), Cindy Dupureur (Associate Professor of Biochemistry), George Gokel (Distinguished Professor of Science), Mike Nichols (Assistant Professor of Biochemistry), Keith Stine (Associate Professor of Chemistry), Chung Wong (Assistant Professor of Chemistry). *Cluster Leader: George Gokel*

This research platform focuses on understanding the fundamental mechanisms of biological systems with an emphasis on enzyme, membrane, and cellular function.

Theoretical & Computational Nanoscience

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Members: Phil Fraundorf (Associate Professor of Physics), Tom George (Chancellor and Professor of Chemistry and Physics), Peter Handel (Professor of Physics), Eric Majzoub (Assistant Professor of Physics), Chung Wong (Assistant Professor of Chemistry). *Cluster Leader: Eric Majzoub*

This research platform focuses on theoretical understanding of nanoscale phenomena and nanoscale systems with extensive use of high-performance computing.

Nanocharacterization & Molecular Imaging

Members: Phil Fraundorf (Associate Professor of Physics), George Gokel (Distinguished Professor of Science), Jimmy Liu (Professor of Physics and Chemistry), Nigam Rath (Laboratory Manager-X-ray Crystallography), Zhi Xu (Associate Professor of Chemistry), Dan Zhou (Laboratory Manager-Center for Nanoscience). *Cluster Leader: Zhi Xu*

This research platform focuses on acquiring major instrumentation and developing/implementing advanced characterization techniques to understand the structure-function relationships of nanoscale materials/devices and biological systems. This platform also provides support/services to industrial partners and non-profit research institutions.

Support positions

To make the newly formed CNS function effectively as a productive research center, to support the Center members, and to help the CNS meet its long-range goals, two new positions were created and filled by the University administration:

- a laboratory manager to oversee the microscopy laboratory and other CNS centralized facilities
- a business and government relations director to oversee and support the daily functions of the Center and the communications/interactions with federal, state and local government agencies and industry communities

The microscopy laboratory (MIST) is an important research resource for the University's science departments and provides an income stream by serving the external academic and industrial community. Dr. Dan Zhou was recruited in January 2007 to manage and develop the centralized microscopy facility within the CNS. Since then, extensive work has been done to reorganize and upgrade the microscopy facility. These upgrades were needed and it is hoped that they will help to attract additional users. As use of the facility increases, so will the visibility of the CNS. Moreover, increased service activity will support the maintenance and operation of the CNS centralized characterization facilities. To date the MIST lab has attracted 17 external users (see appendix F for details) and, since January 2007, it has brought in close to \$40,000 in revenue. It is expected that the CNS centralized lab will significantly increase revenue during the next 2-3 years. With the current major instrumentation, future acquisition of major research instruments and expertise, CNS will become a regional center of excellence in nanocharacterization.

To support the daily operation and administrative tasks of CNS and to coordinate public relations, grants, contracts and endowments, in January 2007 the University recruited Ms. Kendra Perry as the CNS Director of Government and Business Relations. With experience in fund-raising, public relations and legislative issues, Ms. Perry is able to leverage a broad contact base within the community and is working to tap local donor sources for endowments and legislators for federal and state appropriations. Ms. Perry has successfully overseen the numerous renovation projects within the William L. Clay building, negotiated contracts with companies in the St. Louis area and other states, and has visited legislators in Washington D.C. (including a personal interview with Senator Kit Bond) and Jefferson City. Ms. Perry has done an excellent job in coordinating Center activities, expanding the Center's visibility, and enhancing CNS' image as an excellent interdisciplinary research center (see appendix G for details).

CNS houses laboratories that are used by graduate and undergraduate students to perform research activities. CNS also provides limited office space for students, a conference room for student and faculty

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group discussions and lounge areas for students to interact with CNS faculty members and peers of different disciplines. The MIST lab provides training for both graduate and undergraduate students to become expert in various types of microscopy including the state-of-the-art electron microscopy techniques. CNS hosts a monthly seminar which is open to all students; the seminar speakers are primarily research leaders from major industrial companies. Over 40 graduate students and post-doctoral fellows are associated with CNS faculty members and are working on CNS research projects.

The Center for Nanoscience directly reports to the Office of Research Administration and, in a dotted line, reports to the College of Arts and Sciences. The CNS director consults frequently with the chairs of the Department of Chemistry and Biochemistry and the Department of Physics and Astronomy, and informs the chair of the Biology Department of major activities. The CNS will perform a 5-year review in the spring of 2009 and thereafter every five years. As part of our own efforts to improve the CNS we will conduct internal reviews every three years.

Center Operation and Budget

The University provides rate funding for the Director and Associate Director of the Center. In addition, the university provides funding for the laboratory manager, a technician, and the government/business relations administrator. A total of \$430,000 per year is funded toward salaries and benefits of the above five administrative staff. Additionally, CNS shares equally with departments all overhead (F&A) from grants accrued to researchers who reside in the Center. The Chancellor's Office and the Office of Research Administration also contribute part of the overhead. Finally, CNS generates revenue from contract work with industry and service to other non-profit research institutions. Combined, these sources of funding cover salaries of the administrative personnel as well as the operating expenses of the center. All faculty Center members except Drs. Liu and Gokel are funded through their respective departments.

The MIST laboratory currently generates revenue to maintain its operation. Although this revenue stream is significantly higher than in previous years, a goal is to make the MIST lab self-sustaining. An effort is underway to expand its capabilities by acquisition of more centralized instrumentation. This will be accomplished by submission of grant proposals and solicitation of donations or endowments. It is expected that the centralized laboratory will continue to expand and ultimately to be a major regional resource.

Accomplishments, Outcomes, and Impact during the Past 18 Months

The Center for Nanoscience is an interdisciplinary research center. It does not have formal course responsibilities although its members have the required teaching load in the corresponding departments. The Center focuses on scholarly activities and on generating extramural funding to support research. During the period 2006-2008, CNS members have been awarded 19 grants totaling \$3,490,788.00 (see appendix H). Many new individual as well as joint grant applications have been submitted. During the same period of time CNS members published over 150 publications in book chapters, peer reviewed journals and peer reviewed conference proceedings (see appendix I). 13 patents or patent applications have been filed. Professor George Gokel was awarded the Midwest ACS Award.

An important Center goal is to provide education in areas not available within the traditional University context. For example, the Center sponsored a very successful week-long "Summer Workshop on Advanced Electron Microscopy" attended by 40 individuals from local research institutions and industry. The Center plans to offer additional general and more specialized research workshops to provide service to the needs of campus students and industrial research scientists.

The Center open house drew national and international attention with news items published in ABCMoney.co.uk, *Business Week*, *Nanotechnology Now*, *Springfield News-Leader*, and Yahoo! Finance. Center members also appeared on a radio talk show (KWMU) to discuss nanoscience and nanotechnology

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and the hydrogen economy. These activities boost the public image of the Center as well as the University.

The Center's research activities, major instrumentation, and modern laboratories helped the three science department to attract talented faculty members to UM-St. Louis. Two of the newly recruited faculty members in the physics and chemistry departments have also joined CNS and will significantly enhance the Center's research platforms.

The CNS is clearly on track to meet its long-term goal of becoming a center of excellence in interdisciplinary research, a nexus for collaborative research, and a champion for translational research.

Translational Research

The Center for Nanoscience focuses on translational research and economic impact. Dr. Zhi Xu and Dr. James Bashkin are examples of these activities. Dr. Xu has patents and disclosures and has licensed his technology to W. R. Grace Company with royalty income of approximately \$120K per year. Additional license agreements are currently under negotiation. Dr. James Bashkin's research activities are funded by external grants and his company NanoVir, which has developed drug-leads to treat HPV. The CNS provides a platform for faculty members to develop breakthrough discoveries into practical and technologically important applications.

Contribution to University

The Center for Nanoscience, within a short period of time, has already enhanced the research status and visibility of UM-St. Louis within the community and region. The Center has not only helped the science departments to attract talented faculty members, it is helping to attract talented local, national, and international students. The CNS is acting as a bridge for UM-St. Louis to interact with local companies and with the general public. The Center provides a new platform for multidisciplinary and cross-disciplinary research activities and programs. CNS members and their research groups regularly attend conferences and present invited or contributed lectures. Our major instrumentation facilities provide unique services to local companies and research institutions. CNS is poised to become a research center of excellence to attract top researchers and students to the UM-St. Louis campus. UM-St. Louis is striving to become a research university and CNS will play a major role in helping the university to achieve that goal.

Additional information on CNS can be found in the following appendixes.

[Appendix A-background on CME/CNS](#)

[Appendix B-CNS open-house & organizational chart](#)

[Appendix C-Jimmy Liu's CV](#)

[Appendix D-George Gokel's CV](#)

[Appendix E-accomplishments and initiatives in the last 18months](#)

[Appendix F-list of industry and external partners](#)

[Appendix G-list of Kendra Perry's activities](#)

[Appendix H-list of awarded proposals](#)

[Appendix I-list of refereed publications in journals and proceedings \(2006- April 2008\)](#)