from the Director...

It is a great pleasure to introduce this issue of Interfaces and to outline several significant events that have happened in the last year in materials and nanoscience research and education. Most exciting is that we have moved our NCMN offices to the new Jorgensen Hall which will house the Physics Department along with several NCMN Central Facilities. We moved our offices and labs in June and by now have found almost all of our files, books and records! The design of Jorgensen Hall is quite attractive with open spaces, wood ceilings and paneling, and multi-floor artwork on the upper floors. We are especially pleased to report that we obtained a highly competitive grant of $6.9 M from the National Institute of Standards and Technology to construct a $14 M Nanoscience Metrology Facility adjacent to Jorgensen Hall. A news release on this development appears on p. 3 of this issue. Construction is underway with completion scheduled for about November, 2011.

Our research funding has accelerated rapidly in the past year. Office of Sponsored Programs data indicate that research grants in FY 09/10 have jumped to about $19.6 M. In addition to the growing quality and activity of our faculty and their programs, we were helped by large grants associated with stimulus funding, the Department of Defense, and the Department of Energy.

...continued on page 2
from the Director...

...continued from page 1

In the latter case, we and our partners have obtained a most competitive grant from ARPA-E on new magnetic materials for hybrid vehicles and other energy systems. In this case, our award was one of thirty-seven total grants chosen from 3700 proposals! An article on this grant also appears elsewhere. This grant complements several other grants from DOE and NSF, including one through the Ames Lab entitled “Beyond Rare Earth Magnets” that focuses on the concern that rare-earth metals and magnets may become increasingly scarce.

We are pleased that several other well-funded collaborative research programs and teams are continuing or beginning. These include the NSF-supported Materials Research Science and Engineering Center: QSPINS, a DOD-funded group on Nanomaterials for Information, Sensing and Energy Systems, and an NSF-EPSCoR-supported team on Nanoscale Hybrid Materials. We also have obtained an NSF-MRI grant for a high-resolution TEM and a DOD grant for equipment for the Nanoscience Metrology Facility.

Several new faculty have joined NCMN recently. These include Lucia Fernandez-Ballester (EM/ME), Linxia Gu (EM/ME), Tino Hofmann (EE), Jinsong Huang (EM/ME), Rebecca Lai (Chem.), Yusong Li (Civil Eng.), Shadi Othman (Bio. Syst. Eng.), Hector Palencia (UNK), and Angela Pannier (Bio. Syst. Eng.). A new hire in Physics, Dr. Xia Hong, will arrive in January. We also note with sadness the passing of Professor Adrian George in Chemistry.

All of our professors are working extremely hard on their individual and group grants, teaching, and service work for national professional organizations and the university. They are a terrific group and a major resource for our university and state.

David J. Sellmyer
The University of Nebraska–Lincoln has received $6.9 million of federal stimulus funding from the National Institute of Standards and Technology to help fund construction of a new nanoscience research facility.

The grant will cover half the $13.8 million cost to construct the Nanoscience Metrology Facility. It will be adjacent to the north end of the new Physical Sciences Building, now under construction north of 16th and Vine streets. Private funds raised by the University of Nebraska Foundation through its Campaign for Nebraska and internal university funds will cover the rest of the construction cost. The National Institute of Standards and Technology is a non-regulatory agency within the U.S. Department of Commerce; the funding comes from the American Recovery and Reinvestment Act of 2009.

“This grant reflects our faculty’s success and our strength in nanotechnology and materials science,” said UNL Chancellor Harvey Perlman. “We are especially pleased to be able to leverage the state’s deferred maintenance investment in the new Physical Sciences Building with this new building.”

The 32,000-square-foot Nanoscience Metrology Facility will provide state-of-the-art laboratories, shared research facilities and administrative space in a central location. Core facilities, equipment, labs and faculty currently are located in several buildings across campus.

“It will provide modern central facilities for nanofabrication, electron microscopy, and other synthesis and characterization laboratories,” said David Sellmyer, director of the Nebraska Center for Materials and Nanoscience. “Also, it will permit new collaborative research that cannot be pursued in our present obsolete departmental buildings and laboratories that are scattered across campus.”

The building will feature flexible, multi-use research space designed to facilitate interdisciplinary collaboration. It will provide a low-vibration, temperature-controlled, low-electromagnetic field environment and clean rooms necessary for world-class research and measurements.

UNL has a growing and nationally recognized research program in nanotechnology and materials science. More than 70 physics, chemistry, engineering and other faculty members from the College of Engineering, College of Arts and Sciences and the Institute of Agriculture and Natural Resources collaborate through the Nebraska Center for Materials and Nanoscience. The university also is home to a National Science Foundation-funded Materials Research Science and Engineering Center focused on nanomagnetics.

“This facility will provide the much needed research space for an interdisciplinary and highly collaborative program of research excellence at UNL,” said Prem S. Paul, vice chancellor for research and economic development. “We’re grateful to Sen. Ben Nelson and Rep. Jeff Fortenberry for the support they have provided in helping us build our research capacity in nanoscience that addresses important challenges in Nebraska and nationally.”

The Nanoscience Metrology Facility is “shovel ready,” meaning its design is complete. Bids are expected to be let in February 2010 construction beginning in April and completion slated for summer 2011. The Physical Sciences Building was designed and is being built to accommodate the facility addition. Physics and astronomy faculty will move into the new 121,000-square-foot Physical Sciences Building this spring.

The new facility “will give a tremendous boost to the research capabilities” of UNL’s nanoscientists and materials engineers, Sellmyer said. “Research funding is expected to double from its present $11 million per year, with many new discoveries, measurement methods, applications and economic development.”
Nano-technology is the science of engineering functional systems and building devices at a subatomic level, and is expected to revolutionize future manufacture technology by bringing products lighter, stronger, greener, cost effective and more precise. Carbon nanotubes (CNTs), including single-walled carbon nanotubes (SWNTs) and multi-walled carbon nanotubes (MWNTs), are ideal building blocks for fabricating nanoscale devices due to their exceptional properties and unique structures. However, to consider the extremely tiny material volume, it is exceedingly challenging to achieve controllable synthesis, manipulation, integration and assembly of CNTs.

By using a home-built laser-assisted chemical vapor deposition (LCVD) system, Dr. Zhou and his colleagues achieved parallel integration of SWNTs into pre-designed micro/nano-architectures through a single-step in-situ growth process. Figure 1(b) shows a schematic diagram of the LCVD growth process. By making use of sharp metallic tips to focus and enhance optical fields, SWNTs would grow selectively at the electrode tips, the highest temperature regions, as shown in Figs. 1(b) and 1(c). By tuning the laser beam polarization, SWNTs could be wired between electrode tips parallel to the laser beam polarization, as shown in Figs. 1(d) to 1(e). Parallel integration of SWNTs into multiple sites was achieved by expanding the laser beam to cover interested regions.

Band-gaps of semiconducting SWNTs are inversely proportional to their diameters. Forming intra-junctions within individual SWNTs, which is also called band-gap engineering of SWNTs, will provide basic electronic units, such as diode and rectifier, within each tube at a subatomic scale. Based on the temperature sensitive growth of SWNTs, Dr. Zhou and his co-workers successfully synthesized diameter variable SWNTs through the LCVD process, in which laser provides an instant temperature variation at a short time span of several seconds. Figure 1(f) demonstrates Raman spectra of a diameter variable SWNT prepared by quickly adjusting environmental temperature during the growth process. Each section of the SWNT, from 1 to 4, exhibits different Raman shifts, corresponding to gradually increased diameters, as shown in Fig. 1(f). This technique will provide a convenient and cost-effective approach to achieve band-gap engineering of SWNTs and fabrication of in-tube devices.

CNTs of different alignments, such as surface-bounded and vertically aligned tubes, yield applications in different fields. Therefore, growth of CNTs with...continued on page 5
controlled alignments is one of the key prerequisites for developing CNT-based devices. Dr. Zhou and his work-fellows achieved an easy approach to control CNT alignments by applying electrical biases of different polarities on metallic electrodes during the LCVD growth process. Surface-bounded CNTs were found to crawl out from the anodes, while vertically aligned CNTs were found to dominate the cathodes, as shown in Fig. 1(g). The alignment control was ascribed to the movement of positively charged catalyst nano-particles in the external electric fields.

**Profs. Peter Dowben, Wai-Ning Mei and Jennifer Brand Collaborate**

**A New Look at Boron Based Semiconductors**

Semiconducting boron carbides have been discussed as suitable materials for solid state detectors of slow neutrons for 50 years, but success has only been observed in the last decade. Using plasma-enhanced chemical vapor deposited films, based on a C2B10Hx icosahedra-like building blocks, detection of slow neutrons and neutron-voltaic (similar to photovoltaics, except with neutrons, not light) properties have been demonstrated. These successes may prove important to high efficiency pixilated solid state detectors for neutron scattering, and inexpensive low power monitoring of fissile materials and reactor neutron production.

**Top:** The optimized structure spin distributions of Fe2-C2B20H14 of the stable ferromagnetic high spin schematic of the co-joined icosahedra structure. As determined from the EXAFS results, the transition metal atoms sit on opposite sides in the apical sites on the adjacent icosahedra.

**Bottom:** The first observation of current generated at zero bias from incident neutrons by a semiconducting boron carbide device.

Key to further development of boron carbide devices is the controlled introduction of impurities to alter the electronic properties (doping). Recently, the successful transition metal (Mn, Fe, Co, Ni) doping of semiconducting boron carbides has proved to be a route to making successful homojunction diodes, and also the means to obtain detailed local structural information about this important but complex material with many polytypes via extended X-ray absorption fine structure (EXAFS) studies. Success in previous attempts to determine the local structure of the undoped semiconducting boron carbides by extended X-ray absorption fine structure (EXAFS) studies has been elusive. Because the transition metal atoms provide a suitable strong scattering center, the local structure has now been obtained for some semiconducting boron carbides using EXAFS at the K-shell of the doping 3d transition metal. Some questions about the local electronic structure of the various boron carbide polytypes can now be addressed.

The 3d transition metals dope semiconducting boron carbides in an unusual manner: pair-wise substitution at the apical sites of adjacent icosahedra (Figure). Because of the favored sites, there is a large local magnetic moment associated with the transition metal atoms dimer pairs. Thus semiconducting boron carbides may be have application not only in fabrication of solid state devices with slow neutron detection applications, but in devices with spintronic applications as well.
DOE Grant - Funds Innovative Nanotechnology Research at UNL

Sellmyer and his UNL colleagues, physicist Ralph Skomski and materials engineer Jeff Shield, are developing materials with stronger magnetic properties that do not contain rare earth metals. They are part of a collaborative team led by the University of Delaware to develop better ways to power hybrid cars, wind turbines and computer discs, among many other applications.

This team, which includes several universities, a federal laboratory and a private company, recently received a three-year, nearly $4.5 million Advanced Research Projects Agency-Energy grant from the U.S. Department of Energy funded by the American Recovery and Reinvestment Act. UNL’s share of the grant is $675,000.

Stronger magnets produce more energy for powering wind turbines and hydroelectric generators. They also reduce the size and power consumption of everything from hybrid and electric cars to computer memory storage devices. Lighter-weight vehicles increase gas efficiency and reduce exhaust emissions.

To better manipulate the magnetic properties of materials, the researchers are using nanotechnology to build material at the atomic scale.

The ability to precisely position every atom in a nanoparticle allows full control of the material’s magnetic properties.

Collaborators at the University of Delaware, Northeastern University, Virginia Commonwealth University, the Department of Energy’s Ames Laboratory and the Electron Energy Corp. also are developing new magnetic nanomaterials, concentrating on techniques that use smaller concentrations of rare-earth metals or composite materials.

Sellmyer said the UNL center’s undertaking is the kind of high-risk, high-reward project the Department of Energy is looking for.

NCMN Education and Outreach Update 2010

NCMN now offers many different supportive services for NCMN faculty members related to outreach. Outreach support provides creative options and administrative help to members in fulfilling the Broader Impacts outreach component in NSF grants. A new Education and Outreach Committee was also formed to offer direction and expertise to outreach activities. Members are Professors Roger Kirby (PHY), Committee Chair, Wonyoung Choe (CHEM), Stephen Ducharme (PHY), Eva Franke-Schubert (EE), Jeff Shield (ME), and David Sellmyer (PHY), NCMN Director.

NCMN participated in a variety of outreach activities this year such as the Big Red Road Show, Sunday Afternoon with a Scientist at the University of Nebraska Museum, Bright Lights Summer Adventures during Engineering Camp, Women in Science Conference, WoPhy09, LPS Professional Development Workshop for science teachers, Osher Lifelong Learning Institute, and many more. Other exciting outreach plans are in the works for the future.

We want to thank all faculty who have contributed significantly to our outreach efforts which include Professors Eva Franke-Schubert, Steve Ducharme, Christian Binek, Youngfeng Lu, and Axel Enders.
Recent Achievements of Center Researchers

Outstanding Publications


R. Lai - received a NSF CAREER Award - proposal title: "Ligand-induced Folding in Peptides for Biosensing Applications".


D. Berkowitz & Blum - "Nebraska Ice," which was created in high-pressure nano-slits.

A. Rajca – received the 2010 UNL Outstanding Research and Creative Activity Award (ORCA). He has discovered a new form of ice (dubbed "Nebraska Ice"), which was created in high-pressure nano-slits.

D. Berkowitz received the 2010 Arts & Sciences Outstanding Research and Creative Activity Award.

W. Choe received the Dean’s Award for Excellence in Graduate Education.


S. DiMagno recognized by American Chemical Society for noteworthy contributions.

A. Rajca - received a UNL Bessey or Cather Professorship.

E. Schubert - NSF Early Faculty CAREER Award 2009.

Sitaram Jaswal - UNL’s Professor Emeritus with the Department of Physics & Astronomy, one of 360 journal reviewers receiving the American Physical Society’s Outstanding Referee designation in 2009, a lifetime honor. APS has 47,000 physicist members worldwide.

P. F. Williams - UNL’s Lott Distinguished Professor Emeritus with the Department of Electrical Engineering, is one of 360 journal reviewers receiving the American Physical Society's Outstanding Referee designation in 2009, a lifetime honor.

Y. Lu - elected as Fellow, Laser Institute of America (LIA).

Y. Lu - named the Lott Professor of Electrical Engineering.

X. Zeng received the 2010 UNL Outstanding Research and Creative Activity Award (ORCA). He has discovered a new form of ice (dubbed “Nebraska Ice”), which was created in high-pressure nano-slits.

D. Berkowitz received the 2010 Arts & Sciences Outstanding Research and Creative Activity Award.

W. Choe received the Dean’s Award for Excellence in Graduate Education.


R. Lai - received a NSF CAREER Award - proposal title: "Ligand-induced Folding in Peptides for Biosensing Applications".

X. Zeng’s paper (with former UNL student Soohaeng Yoo) was selected as Editor’s Choice of 2009 in the JCP and made the Top 20 Most Downloaded Articles list for March 2010.

X. Zeng’s article “Isomer Identification and Resolution in Small Gold Clusters” was highlighted on the The Journal of Chemical Physics home page.

X. Zeng’s research on hydrophobicity featured by NSF, eScience, UNL, Science360, CCN.


Promotions & Tenure

Ruqiang Feng - promotion to Professor, tenured 2010

Mehrdad Negahban - promotion to Professor, tenured 2010

Anuradha Subramanian - promotion to Professor, tenured 2010

Christian Binek - promoted to Assoc.Professor, tenured 2009

Li Tan - promotion to Assoc. Professor, tenured 2010

New Jobs and Promotions

Jie Xiao - Placement as a Post-Doctoral Associate with Hans-Peter Steinrück at the University of Erlangen, Germany.

Ning Wu - Placement as a Post-Doctoral Associate at UNL.

Srinivas Polisetty - Placement as a Post-Doctoral Associate at UNL.

Andrew Baruth - Placement as a Post-Doctoral Associate with Christopher Leighton at the University of Minnesota.

Aleksander Wysocki - Placement as Post-Doctoral Associate at UNL.

Christina Othon, (PhD 2005) has been appointed Asst. Prof. at Wesleyan University in Storrs, Connecticut effective Fall 2010.

Arosha Goonesekera (PhD 1998) has joined Carl Zeiss SMT Semiconductor Metrology Systems in Santa Clara, CA.

Shin Moteki, PhD - Asst.Prof.at Kyoto University (Aug 09) - Takacs

Hector Palencia, PhD - Asst. Prof. at UNK (Aug 09) - Takacs
Student Awards and Honors

Joan Dreiling, a grad. student in Physics, under Dr. Gay has been selected to attend the Lindau Nobel Laureate Meeting in Germany this summer 2010.

Karolina Janicka has received the Fling Fellowship for 2010-11 EE grad. students Chad Kamler and Craig Zuhlke were awarded Woollam Fellowships for the 2009-10 along with one graduating senior, Bahar Laderian.

Jie Xiao, PhD - PHYS and ASTR, UNL Aug. 2009 Folsom Distinguished Doctoral Dissertation Award Honorable Mention 2010, Humboldt Post-doctoral Fellowship 2010 - Dowben

Ning Wu, PhD - PHYS and ASTR-UNL, Aug 2009; Post-Doctoral Associate at UNL and Frank and Marie Wheeler Fellowship, UNL 2007-08 - Dowben

Nan Shao received the Outstanding Graduate Research Assistant Award Honorable Mention in 2010 - X. Zeng.

Roberto Fabio Delgadillo Moralles won the departmental outstanding graduate student research award May, 2009 - Parkhurst

Robert Jacobberger, CHME (UNMC) awarded the prestigious Barry M. Goldwater Scholarship 2010 - Namavar & Cheung

Paul Goodman, Electrochemical Research, SMART program scholarship - Redepenning

BS Graduates (Aug 09- Dec 09):

Travis Johnston, BS May, 09 - Math Grad, USC - Ducharme

Ben Hage, BS May 09 - PHYS Grad., UNL - Ducharme

PhD Graduates: (May 2009)

Andrew Baruth, PhD - PHYS - Adenwalla Thesis: “Exchange Coupling at Cobalt/Nickel Oxide Interfaces”


PhD Graduates: (August 2009)

Jie Xiao, PhD - PHYS - Dowben Thesis: “The Study of Molecular Band Offsets at the Heteromolecular Interface”

Ning Wu, PhD - PHYS - Dowben Thesis: “The Electronic Band Structure of CoS2(100)”

Xiaokang Shen, PhD - EE - Y. Lu Thesis: “Laser-Induced Breakdown Spectroscopy with Improved Detection Sensitivity, Selectivity, and Reliability”

Chad William Killiblane, PhD - CHEM - X. Zeng Thesis: Investigations into the structural and electronic properties of small clusters of silicon, gold and carbon”

Jack William Maseberg, PhD - ENGR - Gay Thesis: “Fluorescence polarization of atomic, dissociated atomic, and molecular transitions induced by spin-polarized electron impact”

Ning Wu, PhD - PHYS - Dowben Thesis: “The Study of Molecular Band Offsets at the Heteromolecular Interface”

Ashwani Kumar Goel, PhD - ENGR - Negahban Thesis: “Thermodynamically Consistent Large Deformation Constitutive Model for Glassy Polymers”

Alexey V. Kamenskiy, PhD - ENGR - Dzenis Thesis: “Coupled Hemodynamics and Mechanics of the Repaired Human Carotid Artery”

Ocelio V. Lima, PhD - ENGR - Li Tan Thesis: “Self-Organized Nanolayers of Conjugated Organosilane Molecules”

Sandra Edith Noriega, PhD - ENGR - Subramanian Thesis: “Role of Scaffold Topography and Stimulation via Ultrasound on the Biosynthetic Activity of Chondrocytes Seeded in 3D Matrices”

Srinivas Polisetty, PhD - ENGR - Binek Thesis: “Exchange Bias Training Effect in Magnetically Coupled Bilayers”

Chaojun Wang, PhD - ENGR - Li Tan Thesis: “Exchange Bias Training Effect in Magnetically Coupled Bilayers”

Aleskander Ludomir Wysocki, PhD - PHYS - Belashchenko Thesis: “Finite Temperature Effects in Magnetic Materials: Model and ab initio Studies”

MS Graduates (August 2009):

Celine Marie Hayot, MS - EM - Negahban
Joshua Rueben Machacek, MS - PHYS & ASTR - Gay
Lucie Denise Rupert, MS - EM - Negahban
Phani Kiran Vabbina, MS - EE - M. Schubert

PhD Graduates: (October 2009)

Srinivas Polisetty, PhD - PHYS - Binek Thesis: “Exchange Bias Training Effect in Magnetically Coupled Bilayers”

PhD Graduates: (December 2009)


Roberto Fabio Delgadillo Moralles, PhD - CHEM - Parkhurst Thesis: “Acceptor Detected Fluorescence Resonance Energy Transfer for Measurementsup to 250Å and Biophysical Studies on Core TATA Binding Protein-DNA Complex”

Ashwani Kumar Goel, PhD - ENGR - Negahban Thesis: “Thermodynamically Consistent Large Deformation Constitutive Model for Glassy Polymers”

Alexey V. Kamenskiy, PhD - ENGR - Dzenis Thesis: “Coupled Hemodynamics and Mechanics of the Repaired Human Carotid Artery”

Ocelio V. Lima, PhD - ENGR - Li Tan Thesis: “Self-Organized Nanolayers of Conjugated Organosilane Molecules”

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Aleskander Ludomir Wysocki, PhD - PHYS - Belashchenko Thesis: “Finite Temperature Effects in Magnetic Materials: Model and ab initio Studies”

MS Graduates (December 2009):

Lingmei Kong, MS - PHYS & ASTR - Gay
Niklas Carle Petter Lingesten, MS - EM - Chandra
Chase William Nielsen, MS - ME - Shield
Xu Zhang, MS - CHEM - Takacs

PhD Graduates: (December 2008)


Students and Honors
**NCMN MEMBER NEWS BRIEFS**

**Collaborative Research & Grants**

“Nanoscience is on the move at UNL” reports Kevin Abourezk in his Lincoln Journal Star article on Sunday, February 28, 2010. Certainly, it would be hard not to notice that something BIG is going on here amongst members of the Nebraska Center for Materials and Nanoscience. One might even say there’s been a “chain reaction” in collaborative research and grant funding, which occurs when one great success challenges another!

**Dr. David Berkowitz** is collaborating with Columbia University and Stockbridge Pharmaceuticals, Inc. for a new cancer treatment. The licensed technology is the result of a “unique approach molecule-based approach for the targeted treatment of various cancers” was developed in collaboration between the laboratories of Dr. Argiris Efstratiadis, Professor of Genetics & Development at Columbia University, and Dr. Berkowitz, Professor of Chemistry at the University of Nebraska.

**Mathias Schubert & 8 UNL co-PIs** - NSF: “MRI: Development of an Optical Hall Effect Instrumentation for non-contact Nanostructure Electrical Characterization”. 10/1/09-9/30/11

**Peter Dowben, Brand, Losovyj, Belashchenko** - DTRA Grant: “Novel rare earth semiconductors to enriched lithium borate semiconductor heterojunctions for next generation solid state neutron detectors”. 12/15/09-6/14/11

**Stephen Ducharme, James M. Takacs, Shireen Adenwalla, David Sellmyer, Alexei Gruverman, Jinsong Huang** - Research Theme: “Study and Application of Ferroelectric Polymer and Oligomer Thin Films and Nanostructures” ongoing

**Harnessing Nanotechnology’s Potential**

**Dr. Gay Aims to Build a Better Light Bulb**

**excerpt from UNL Office of Research Website 2/22/10**

UNL physicist Tim Gay is developing a turnkey source of spin-polarized electrons with a $610,000 grant from the National Science Foundation funded by the American Recovery and Reinvestment Act (ARRA).

**Dr. Jody Redepenning** has discovered a one-step process that creates synthetic bone. The process involves an amonomer, L-lactide, made from the ethanol refining process & heated.

**Dr. Mathias Schubert** announces that Asst. Prof. Tino Hofmann received the 2010 Paul Drude Award at the 5th Intl Conference in Spectroscopic Ellipsometry-Albany, NY on May 22-26.

**Dr. Yiqi Yang** is hoping medical uses for tiny nanoparticles and nanofilters made from a corn ethanol by-product will be part of the next big thing for the state's biggest crop. The hollowed out particles, made from the corn protein called zein, show potential to deliver cancer-fighting drugs to the brain. Also made from zein, the filter material is about .001 the thickness of a human hair. Pulling zein out of distillers grain, it is a dry, yellowish powder potentially cheap to produce.
NCMN MEMBERS CELEBRATE MANY RECENT RESEARCH BREAKTHROUGHS IN NANOSCIENCE

...at the Nebraska Center for Materials and Nanoscience

The TEXTURED Images of NANOSCIENCE...