DIRECTOR’S STATEMENT

May again and it seems that our NEAT newsletter is indeed a rite of spring. Here I summarize what seeds have been planted and what has blossomed in the past year.

Proposals and Grants: NEAT submitted 15 research proposals ($9,628,312.84) in this period. Additionally, we secured funding for 5 new projects totaling $669,446.93. Our most exciting prospect has come from an NSF MRSEC (Materials Research Science and Engineering Center) proposal. A reverse site visit was done on May 22 in Washington DC to defend our proposal, entitled "Materials Center for a Sustainable Environment", with NEAT faculty Giulia Galli as director. The proposal's two Interdisciplinary Research Groups (IRGs) are "From Clusters to Solids: The Aqueous Reactivity of Oxide Clusters, Nanocrystals and Ceramics" (Navrotsky, Leader) and "Proton Conducting Oxides: Interface and Nanoscale Effects on Transport Properties" (Mark Asta, Leader). Many NEAT faculty are also participants in the NSF Center for Environmental Impacts of Nanotechnology (CEIN) proposal (Kent Pinkerton, PI), which also had a reverse site visit in May.

Energy: The Energy for the Future Initiative has led to the formal recognition of a university wide Energy Institute, which is currently seeking a director. The exact relations between this organization and groups like neat, which to both energy-related and other research, are still being worked out. Faculty searches are still in progress.

Staffing: We believe our office is now running smoothly and we hope we provide you the service you need in terms of proposal and grant administration and the encouragement of interdisciplinary activities. Please do not hesitate to provide feedback to me and/or Carlos. As I constantly remind my research group, a problem we do not know about cannot be fixed.

Budget: We all know these are uncertain times and budget cuts are planned. The details are not yet finalized. I trust “the university will not kill the goose that lays the golden eggs” and realize that research and ORUs deserve continued support to enable externally funded work and research excellence to flourish. Certainly I will fight hard for NEAT, but the important thing is that we continue our successful and expanding research program.

ICAM - THE INSTITUTE FOR COMPLEX ADAPTIVE MATTER

Because the collective phenomena of assembled systems are rarely a simple function of the well-understood properties of the pieces, the goal is shifted to finding the organizing principles that drive emergent behavior at given length and time scales. It is this primary scientific strategy and philosophy that underlies the Institute for Complex Adaptive Matter, an open distributed experiment-based dynamic multi-institutional partnership whose purpose is to identify major new research themes in complex adaptive matter and to nucleate and conduct collaborative research and scientific training that links together scientists in different fields and different institutions. ICAM science is centrally focused on three areas: (i) strongly interacting electron materials such as the new iron-pnictide superconductors; (ii) biological matter such as self assembled protein aggregates in viral capsids or Alzheimer’s disease victims, (iii) soft materials like liquid crystals.

ICAM’s is a massive scientific network with an integrated scientific and educational program including exploratory workshops, schools for junior scientists, fellowships, travel awards for junior scientists, and education outreach efforts such as our nascent...
virtual science museum called "The Emergent Universe". It has a well-developed communication, governance and advisory structure. Moreover, at each branch there is in turn an interdisciplinary grouping at the local level – from materials science, physics, chemistry, and biology, from theory and experiment. ICAM's activities are currently supported by the National Science Foundation, Los Alamos National Laboratory, the A.P. Sloan Foundation, the Trinity Capital Corporation and cost sharing contributions from its branch members.

New Branches Span the Globe
The most recent additions to the ICAM-I2CAM network represent 6 countries and 17 institutions. We are delighted to in the past year and a half

- Rice University
- UCLA
- University of Wisconsin
- Ohio State University
- IFI Rossendorf
- Forschungzentrum Juelich
- Scottish University Physics Alliance/Bristol Consortium
- Stony Brook/BNL/Columbia Consortium
- Nordic-Baltic Consortium
- University of Colorado, Boulder
- Hong Kong University of Science and Technology
- Massachusetts Institute of Technology
- Johns Hopkins
- J. Nehru Center for Advanced Scientific Research

Some of these institutions need no introduction. All bring to the ICAM community strengths and resources in a broad range of research areas.

Where Do We Go from Here?
In just eight years, ICAM-I2CAM has grown from nine founding branches to over fifty, representing over eighty institutions, with more waiting in the wings. Its workshop alumni number in the thousands, with participants coming from extremely diverse fields: Physics, Chemistry, Mathematics, Materials Science, Biomedical Engineering, Chemical Engineering, Electrical Engineering, Geology, Biochemistry, Cell Biology, Molecular Biology, Neuroscience, and a number of departments in Medical Schools. And as the Institute evolves, its initial focus on correlated electron matter, reflecting the orientations of the founders, is being balanced by an increasing emphasis in its workshops and symposia on soft and biological matter.

When asked for his vision of what lies ahead for ICAM-I2CAM, Daniel Cox replied: “I am quite excited about concretizing the virtual organization aspect of ICAM through online research communities of the kind suggested by Hilal Lashuel at our EPFL branch in Lausanne for amyloid matter. The idea here is to develop online sites that are go-tos for information, collaborative projects, research literature, online modeling systems, etc. If we encourage workshops that aim to develop such sites for new research areas, we can enable more rapid progress in lots of additional exciting areas, such as neuroscience and novel materials that enhance our energy supplies.” With co-director David Pines, the ICAM efforts in science outreach will continue to expand.

**EQUIPMENT AND FACILITIES NEWS**

Yayoi Takamura's lab christens new pulsed laser deposition system.
Pulsed laser deposition (PLD) refers to a thin film growth technique that uses a pulsed laser to ablate material from a ceramic target which then deposits on a substrate. This technique permits the growth of high quality thin films and superlattices of perovskite structured materials with atomic layer precision. A reflective high energy electron diffraction (RHEED) system provides in-situ monitoring of the growth process, including determination of the growth mechanism (layer-by-layer, step flow or three dimensional island growth) and
counting of the growth of individual atomic layers. PLD offers a number of advantages over other thin film deposition techniques that make it particularly attractive for research activities. These advantages include the applicability to a wide range of materials including metals and complex oxides as long as they absorb at the wavelength of the pulsed laser, stoichiometric transfer of target material into the film, and its non-equilibrium nature permits the deposition of phases and structures of materials in thin film form which are not thermodynamically stable in the bulk form. We have installed a state-of-the-art PLD system from NBM Design equipped with a KrF (248 nm) Coherent Compex Pro 201 laser. The system is capable of growing films of up to six different materials while varying the deposition conditions over a wide range of substrate temperatures (RT to 1100 °C), oxygen/nitrogen pressures (10⁻⁷ to 1 torr) and with adjustability of the x-y-z position of the substrate heater.

SPECTRAL IMAGING FACILITY

The NEAT ORU Spectral Imaging Facility supports investigation and research in bio-nano and nanomaterials, supported by an instrumentation grant from the National Science Foundation MRI program. The facility has a state-of-the-art (CCOAFM) high resolution combined Atomic Force Microscope and Laser Scanning Confocal Microscope implemented with the Asylum Research, Inc. MFP3D atomic force microscope and the Olympus America FV1000 laser scanning confocal microscope.

Through an instrument gift from Agilent, Inc., the facility recently acquired an Hitachi High Technologies America, Inc. S-800 turbo FE-SEM (Field Emission Scanning Electron Microscope) with an Oxford Instruments, Inc. INCA Energy EDS (Energy Dispersive X-ray Spectrometry) attachment which allows for digital electron micrograph capture, as well as, nano-feature elemental analysis.

The shared use facility on the UC Davis campus is located in Chemistry Laboratory 0011. The basement location was chosen specifically for the low vibration environment required by the ultra-sensitive CCOAFM imaging system. Additional quiet laboratory features include a half-ton isolation chamber for the CCOAFM positioned on a vibration-dampening pad.

The operating goal of the Spectral Imaging Facility is to become self-supporting by recharging University of California users and affiliates at tiered rates for both weekday and after hours instrumentation use. Users may submit samples for imaging or complete instrument user training and become a certified user with the associated privilege of after hours access at a reduced recharge rate. Also available for general use is a dedicated computer work station affording image analysis using off-line versions of the instrumentation software. Please contact the development engineer for the facility, Mr. Alan Hicklin (aghicklin@ucdavis.edu), for details regarding training, scheduling, and advice on sample preparation. See also facility information under Spectral Imaging Facility at http://neat.ucdavis.edu/.

STUDENT ACCOLADES

Erica Gjersing, a graduate student in Prof. Sen’s research group, has been awarded a NSF EAPSI Fellowship (East Asia and Pacific islands Summer Institute) to conduct research in Japan for 8 weeks in summer 2008. The project, entitled “High Temperature NMR Spectroscopy to Assess Dynamics of Chalcogenide Glasses”, is in collaboration with Prof. Hideki Maekawa of Tohoku University in Sendai, Japan. The award provides a $5000 stipend from NSF while all travel and living expenses in the host country will be paid for by the Japan Society for the Promotion of Sciences (JSPS). The EAPSI program fosters international collaborations by enabling U.S. graduate students to conduct world class research in addition to learning about the language and culture of their host country.
Peter Greene: 2nd Prize, Steven Chu Award for Best Undergraduate Research at the 2007 American Physical Society - California Section Meeting, Oct. 27, 2007.

Randy Dumas: UCD Summer Graduate Student Researcher Award

Dr. Moran Wang, currently a postdoc at UC Davis, has just been awarded by the Los Alamos National Laboratory (LANL) the prestigious J. Robert Oppenheimer (JRO) Distinguished Postdoctoral Fellowship. The JRO fellowship is open to all nationalities and up to only two awards each year for those who "display extraordinary ability in scientific research and show clear and definite promise of becoming outstanding leaders in the research they pursue". Working under Professor Ning Pan, a faculty member in Textile & Clothing, Biological & Agricultural Engineering, NEAT and Chemical Engineering & Materials Science, Dr. Wang is continuing his work on computational modeling of multi-physical behaviors of complex materials systems. In less than two years, Dr. Wang has published more than ten scientific research papers in highly reputable journals focusing on transports and properties of various porous media, composites, functional gradient materials, and multiphase material systems.

High school student Divya Nag was awarded 1st Place in the Northern California Senior Division, Earth and Environmental Sciences as well as a Silver Medal at the California Science Fair for her poster entitled “Thermal Analysis and Thermogravimetry Techniques to Quantify and Prevent Forest Fires”. Her poster was judged on criteria including creative ability, scientific thought, thoroughness, and clarity of presentation. Divya has been working with Sergey Ushakov in the Navrotsky lab and is planning to return for another project during her senior year.

FACULTY AWARDS

Kai Liu was presented with the UC Davis Chancellor’s Fellow award in February of 2008. The award designates "faculty who, early in their careers, already have distinguished themselves in teaching, research and public service." Professor Liu has been described as "an international leader" in fundamental research on spin-dependent electron transport and magnetic phenomena at the nanometer scale, two areas likely to be critical in ongoing improvements in the transmission and storage of information. As part of NEAT, Liu "has been acting synergistically with faculty in physics, chemistry, geology, and chemical and electrical engineering."

Alexandra Navrotsky was awarded with the College of Engineering Outstanding Engineering Senior Career Research Award in November 2007. Recipients of Senior Research Faculty Awards have a record that clearly demonstrates excellence in research as evidenced by especially high achievement in the quality and significance of their research record. Candidates whose credentials place them among the top of their peer group are awarded in this way.

Subhash Risbud, Distinguished Graduate/Professional Teaching Award for Graduate Research, Publications, and Mentoring of Ph.D. students. The award was given to Professor Risbud in February 2008 by the UC Davis Academic Senate.

Yayoi Takamura, National Science Foundation (NSF) CAREER Award. Prof. Yayoi Takamura of the Department of Chemical Engineering and Materials Science received a five-year NSF CAREER award to support her work entitled "Multifunctional Heterostructures of Perovskite Structured Materials". This work combines growth and characterization of thin films and heterostructures to understand the origins of unexpected physical phenomena that result from the changes in structure and chemistry which occur over nanometer length scales at surfaces and interfaces. The Faculty Early Career Development Program supports the early career-development activities of those teacher-scholars who effectively integrate research and education.

Sangtae Kim has received tenure.

NEW GRANTS RECEIVED, June 2007 - April 2008

Alfred P. Sloan Foundation: To Develop a Treatment for a One-hour PBS documentary on John Bardeen - David Pines, PI

NSF: MRI: Development of a New Paradigm for Apertureless Near-Field Scanning Optical Microscope - Gang-yu Liu, PI

NSF: ICAM (Institute for Complex Adaptive Matter) – David Pines, PI

NSF: ICAM-IMI (International Materials Institute) - Daniel Cox, PI.

NSF via Caltech: Chemical Bonding Centers Phase II: (CBC-II) Chemistry as the Driver for Transformative Research and Innovation – Giulia Galli, PI.

Shell International Exploration and Production, Inc.: Stability and formation of methane under high pressure: Equation of state and reaction mechanisms from ab-initio simulations – Giulia Galli, PI.

UC MEXUS: Electrical Transport and Thermodynamics of Interfaces in Naoceramic Materials for Fuel Cells - Alexandra Navrotsky, PI; Sangtae Kim, Co-PI.

NEW PROPOSALS AIM TO BRING CENTERS OF EXCELLENCE TO UC-DAVIS

The UC Davis Center for Environmental Implications of Nanotechnology (CEIN), an invited proposal submitted to the National Science Foundation in March, will investigate a wide variety of interactions of naturally derived and engineered nanomaterials and the living world, and the social and economic implications of these interactions. The CEIN brings together a diverse, interdisciplinary group of more than 60 investigators at UC Davis and other institutions to address the past, current, and future implications of a rapidly growing technology that has unknown consequences in our environment. The proposal is currently under review at NSF with a funding decision to be made some time this summer.

A proposal for a Materials Research and Engineering Center (MRSEC), submitted to NSF through NEAT by a team of researchers including Giulia Galli (Director), Robert Powell (Deputy Director), Alexandra Navrotsky (IRG-1 Leader), and Mark Asta (IRG-2 Leader), was invited to Washington D.C. on May 22nd, 2008 for a reverse site visit. The proposed center (MaCSE) will focus on environmental issues including climate change, pollution, and the related need for reliable and durable energy supplies. These issues have been attracting the interest of an increasing number of scientists worldwide. The development of advanced materials is widely recognized as one of the key elements for creating the new technologies that are required to achieve a sustainable environment and provide adequate, clean energy for our planet. Such sustainability relies on the transport and fate of environmental contaminants, and on the control and reduction of their emission. The long-term goal of MaCSE is to develop the fundamental scientific tools to synthesize, characterize, understand and predict the fundamental properties of new materials, relevant to the creation of novel and efficient energy supplies, within a more sustainable environment. These tools encompass catalysts for solar energy conversion, materials for nuclear waste disposal, and materials for energy applications. Against this backdrop, the Center educates students to tackle one of the most challenging problems of this century: technological advancements within a sustainable framework.

NEAT IN THE NEWS...

The NEAT ORU is sponsoring the 13th conference on High Temperature Materials Chemistry (HTMC-13). The multi-day conference will take place September 14-18, 2009 on the UC-Davis campus. More information can be found at: http://NEAT.ucdavis.edu/HTMC-13.

On April 7, 2008 an interview of Alexandra Navrotsky was featured in the Sacramento Bee newspaper as part of a story on the fate of nanomaterials in the environment entitled "Tiny silver particles in clothing may lead to pollution, research suggests".

NEAT ORU BENEFactors - March 2007 through May 2008

Setaram Instrumentation (Alexandra Navrotsky)
Intel Corporation (Giulia Galli)
Hitachi High Technologies America, Inc. (Gang-yu Liu)

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RECENT NEAT FACULTY COLLABORATIVE PUBLICATIONS

February 2007 – June 2007 (12)


NEAT FACULTY AND STAFF UPDATES

Recent NEAT Staff Hires:
Beth House, NEAT Financial Analyst, hired August 2007
Charlie Laub, Executive Assistant to the Director, hired October 2007
Alisa Harrison, NEAT/ICAM Program Coordinator, hired May 2008

Retiring:
John Neil, Senior Research Scientist and Calorimetry Lab Resource Manager, retiring June 2008
Not retiring anytime soon despite an imminent 65th birthday:
Alexandra Navrotsky, Director

NEAT ORU, 4415 Chem Annex, University of California, Davis ● (530) 752-4353 ● NEAT.UCDAVIS.EDU
THESES FROM RECENT NEAT GRADUATES

Justin Olamit: Effects of Anisotropy and Domain Structures in Exchange Biased Thin Films
Joseph Davies: First Order Reversal Curve Studies of the Magnetization Reversal Behavior in Nanoscale Magnetic Materials
Michelle Morcos: Energetics of nanostructured, amorphous, and molten materials related to technology
Peng Zhang: Energetics of nanophase zinc and yttrium oxides
Nhu Le: Energetics of cobalt phosphate, zinc phosphate, and copper phosphate frameworks
Pingping Sun: Synthesis, characterization, and energetics of zeolites

NEAT REVIEW POSTER SESSION

As part of the 2008 NEAT ORU review to be held July 21-22, a lunchtime poster session will be held. There are over 20 posters representing various aspects of research from NEAT members and collaborators, include the following:

"Carbon-Isotope Signatures of CO2 Occluded in a-FeOOH and Al(OH)3" - Piotr Zarzycki (postdoc) and James Rustad
"Carbon and Boron Isotope Fractionation in Aqueous Nanoclusters" - Sierra Nelmes and James Rustad
"Water Exchange Rates on Aluminum Oxide Nanoparticles" - James Rustad and William H. Casey
"The Equilibrium Isotopic Composition of Carbon and Nitrogen in Amino Acids" - Caitlin Farnsworth and James Rustad
"Comparison of Bulk and Thin Film Energetics by High Temperature Calorimetry La(Sr)MnO3 / La(Sr)FeO3 Perovskites" - Nihan Kemik
"TiO2 Stability Landscape: Polymorphism, Surface Energy and Bound Water Energetics" - Andrey Levchenko
"Peter A. Rock Thermochemistry Laboratory" - A. Navrotsky (presented by Sergey Ushakov)
"Gas adsorption calorimetry: probing energetics of oxide surfaces" - S.V. Ushakov and A. Navrotsky
"Y2O3 nanoparticles" - Peng Zhang et al. (presented by A.Navrotsky)
"Nano-Structured Thin Gold Films for Aqueous-Phase Infrared Spectroscopy and Biological Sensors" - Travis Ruthenburg, Terry Ng, Simon Park, and Donald P. Land
"Rapid Nose to Brain Transport of Inhaled Quantum Dots" - Laurie Hopkins
"Inhalation Exposure to Aerosolized Carbon Nanotubes" - Amy Madl
"STM Investigation of SAM-based Molecular Electronics: The significance of Local Density of States" - Christopher Fleming
"Physical Modeling of Amyloid Matter at the NanoScale" - D. Cox
"DNA analysis for MTBE degrading bacteria and antibiotic resistance using magnetic/luminescent nanoparticles" - Ahjeong Son, Dosi Dosev, Mikaela Nichkova, Ian Kennedy, and Krassimira Hristova
"Correlation-driven collective order at oxide heterointerfaces" - Warren E. Pickett and Rossitza Pentcheva
"Magnetic luminescent nanoparticles (MLNPs) for internal calibration in multiplexed immunoassays" - Dosi Dosev, Mikaela Nichkova, Zhi-Ya Ma, Shirley J. Gee; Ian M. Kennedy, Bruce D. Hammoek; Dan Chang
"Single Domain to Vortex State Transition in sub-100nm Fe Nanodots" - Randy Duma