(Credit: Radovic; TAMU.)

Radovic and his student, Peipei Gao, demonstrate the resonant ultrasound spectrometer developed as a part of this project.

Class of 2011 National Science Foundation CAREER Awards in Ceramics

By Lynnette D. Madsen

In 2011 the National Science Foundation's Ceramics Program awarded a record number of Faculty Early Career Development (CAREER)[1] grants from a stellar group of proposals. The six awardees (twice the number of 2010)[2] began their projects approximately one year ago. Below is a snapshot of what these young faculty have underway.

Miladin Radovic at Texas A&M University is interested in gaining a better understanding of oxide ceramics with high ionic or mixed ionic-electronic conductivity for solid oxide fuel cells and batteries. His primary focus is on point defects and effects of their association and clustering on the mechanical behavior and transport properties of oxide ceramics. Broad educational impact is achieved by providing high school through graduate students with hands-on training and incorporating the latest research results into new materials science and renewable energy courses. An exchange student from the British University in Cairo also works on this project in collaboration with the NSF-supported International Institute for Multifunctional Materials for Energy Conversion. TAMU promoted Radovic to associate professor. (Award 1057155)

Ricardo H.R. Castro at the University of California, Davis studies ways to use the larger fraction of interfaces in nanoceramics and the effect of dopants on their energies to improve processing control on a thermodynamic basis. His group is building new phase diagrams for nanoscaled oxides and showing that pore volume control can be promoted by targeting the energetics of the system. Critical to his work is the use of unique calorimetric techniques to measure interfacial energies (surface and grain boundary) and determine the role of composition changes. Room- and high-temperature energies can be assessed by using these techniques, providing unprecedented data on

(Credit: Castro; UC Davis.)

Castro uses high-temperature differential scanning calorimetry and thermogravimetry instrumentation to understand the energetics of sintering nanoceramics.

the thermodynamics of nanoceramics at operational conditions. Castro has recently edited a book on sintering nanomaterials. Also, he has initiated a program, "Materials & You: Bringing Materials Concepts to Your Life," to show middle- and high-school students how "cool" materials are by performing in-class demonstrations of strong materials, smart materials and nano-supermaterials. Castro has designed educational kits for these activities (to be made available on-line) and used them to successfully inspire students from two local schools with a majority of underrepresented students. He received the 2011 Society of Hispanic Professional Engineer Outstanding Young Investigator Award and the 2012 Outstanding Junior Faculty Award from the UCD College of Engineering. The university promoted Castro to associate professor earlier this year. (Award 1055504)

Bilge Yildiz of the Massachusetts Institute of Technology is advancing the understanding of mechano-chemical coupling on surfaces of functional oxides crucial to fast oxygen transport and electrocatalytic activity that could impact technologies for solid oxide fuel cells, sensors and batteries, and how materials age. Recent advancements in her laboratory of in-situ scanning tunneling microscopy and spectroscopy at elevated temperatures and in reactive gas conditions are critical because she studies these materials in harsh environments. This grant is cofunded by NSF's Office of International Science and Engineering and will provide her the opportunity to collaborate with Professor Juergen Fleig at Vienna University of Technology in Austria. Yildiz is a 2012 recipient of the International Union of Materials Research Societies' Somiya Award for International Collaboration. As well, the Electrochemical Society selected Yildiz as a 2012 Tobias Young Investigator Award Winner. Her research results will be disseminated at the MIT museum to educate the public on the importance of research on materials for clean and affordable energy. An outreach program for K–12 youth to undergraduate students with individual mentoring and long-term tracking by Yildiz is intended to broaden the participation of groups often underrepresented in science and engineering careers. MIT recently promoted Yildiz to associate professor. (Award 1055583)

(Credit: Yildiz, MIT.)

Yildiz in her laboratory.

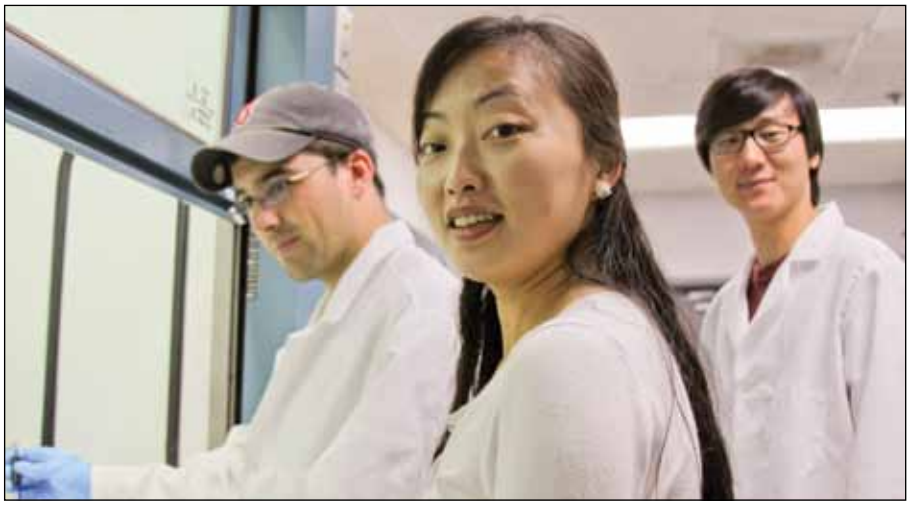
(Credit: M. Dawber, SUNYSB.)

Dawber working on the off-axis rf magnetron sputter deposition system in his laboratory in the Department of Physics and Astronomy at Stony Brook University.

Matthew Dawber at Stony Brook University (part of the SUNY system) is developing new, artificially layered materials with engineered electrical and magnetic properties. Earlier this year, Physics published a viewpoint by Dawber about the discovery of a material in which electronic ferroelectricity is opposed to, and overpowers, ionic ferroelectricity. Dawber's lab is equipped with a suite of cutting edge tools, and he also takes advantage of facilities at Brookhaven National Laboratory to probe the physics of these new materials and drive them toward optimization. His group also conducts experiments at the Swiss Light Source at the Paul Scherrer Institute, which has a unique surface diffraction beamline ideally suited for this work. This grant is cofunded by NSF's Office of International Science and Engineering and the Condensed Matter Physics Program.

The project already has resulted in the development of two new artificial ferroelectric materials. In one structure, a normally metallic material is used as a novel dielectric layer to compositionally break the inversion symmetry, which may lead to self-poled ferroelectrics and enable coupling between polarization and magnetism. In the other structure, an enhanced piezoelectric response is obtained by rotating the ferroelectric polarization direction of two materials by harnessing their competing tendencies. So far, Dawber has published one article in connection with this project. Tightly integrated with the research efforts is an educational outreach program built around the development and dissemination of a set of unique and engaging teaching kits. Specific efforts are made to target diversity goals, largely by tapping into the extraordinarily diverse student community and existing educational outreach programs at Stony Brook University. (Award 1055413)

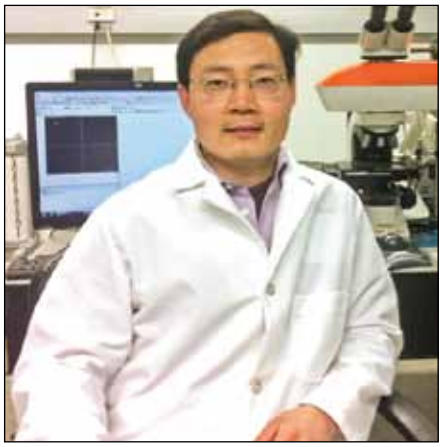
Ying Shirley Meng's research at the University of California, San Diego targets reversible energy storage, specifically, the systematic synthesis, structural characterization and properties evaluation of a series of transition metal oxides $xA_2MnO_{3\cdot(1-x)}A_y(NiMn)O_2$



(Credit: Jacobs School of Engineering, UCSD)

Meng with her postdoctoral researcher, Kyler Carroll, and graduate student, Daniel Lee.

(where A represents the Li^+ and Na^+ mobile species). There are three prongs to her education efforts: vertical integration of precollegiate, undergraduate and graduate education and training through tools, practical examples and hands-on laboratory experiences; increased appreciation of diverse culture, education and research approaches; and international experiences. She has published one paper so far in connection with this grant, reporting that significantly improved power density can be achieved in Na/Li energy storage materials. In July 2012, she represented the Unites States at the International Conference of Young Researchers on Advanced Materials held in Singapore, where she served as a panel member for the discussion of the future of materials research for energy storage and gave an invited talk. The mission of ICYRAM is to provide a platform for outstanding young researchers to present their research, network within the international community of their peers and broaden their general materials-based knowledge. Funding came from the NSF-funded International Materials Institute for Solar Energy and Environment. (Award 1057170)



(Credit: Wu, UC Berkeley)

Wu operating micro-Raman spectroscopy on some oxide samples.

Junqiao Wu at the University of California, Berkeley studies the controlled manipulation of domain walls. A full understanding of the static and dynamic properties of domain walls could impact fields such as ferroelectricity, magnetism, shape memory alloys and even seismology. To date, he has published four papers related to this project.

His educational activities involve building a program to broaden the impact of nanoscience in the San Francisco Bay area, for example, through a partnership with the nearby museum, the Lawrence Hall of Science at UC Berkeley. His group has recently organized and hosted outreach activities with the Techbridge afterschool program for girls and local elementary schools. The university recently promoted Wu to associate professor. (Award 1055938)

Career–Life Balance

At any given time, NSF supports more than 3,000 CAREER awards. In the summer of 2012, 323 projects were supported within the Division of Materials Research, which is home to the Ceramics Program. The Ceramics Program supports 25 of these CAREER grants—and this number is an underestimate of the assistant professors supported.

Recognizing that there is a critical time for parenthood early in academic careers, NSF has instituted a Career–Life Balance Initiative,[3] which includes special options[4] for the CAREER program.

This initiative encourages flexible award start dates, no-cost extensions and virtual panel participation, and provides recommendations for local child care during short-term, on-site NSF service (for example, as a panelist). For CAREER awards in particular, supplemental funding requests (up to $12,000 or three months salary) are available to support additional project personnel to carry on the research when the principal investigator is on family leave. Women are not alone here: Several of the male principal investigators have also expressed an interest in leave policies and practices that would allow for more active parenting.

The underlying basis for NSF Career-Life Balance Initiative is to help retain more early-career talent in academic positions and make the US more competitive. Even though women continue to earn an increasing proportion of science and engineering doctoral degrees, this representation is not reflected in full-time faculty positions.

Acknowledgments

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[3]http://www.nsf.gov/career-life-balance/and http://www.nsf.gov/career-life-balance/suppfunds.jsp

[4]http://www.nsf.gov/pubs/2012/nsf12065/nsf12065.jsp ■