NREC
Nanotechnology Research & Education Center

Nano Wired

VOLUME I, ISSUE I FALL 2010

NREC MISSION

- Enabling multidisciplinary nano-related research for faculty at USF
- Providing professionally-managed facilities for fabrication and characterization
- Providing training programs for faculty and students
- Enabling industrial and academic collaboration for commercialization of technology

INSIDE THIS ISSUE:

Director's Note

Ashok Kumar, Ph.D., FASM
Director, NREC
Professor, Dept. of Mechanical Engineering

It gives me great pleasure to share our first newsletter with you as the new Director of the Nanotechnology Research and Education Center (NREC). We have recently changed the name of the Center and the new name truly reflects the nature of the work that NREC contributes both in education and research areas for the USF community. I have setup new advisory boards comprising of members from both academia and industry, and they have provided valuable feedback to promote interdisciplinary research and increase the number of NREC users. The NREC has also taken a very strong commitment to integrate education and research, and our dedicated staff members are involved to promote a wide variety of educational missions for the university. The NREC has grown it's user base continually each year and also steadily increased cost recovery revenue ($175K in 2009-10). The NREC will be committed to explore more revenue streams for the Center in spite of the tough economy.

On behalf of NREC affiliated members and staff, I would like to personally thank ex-director Dr. Mike Kovac for his vision and passion for the center that is now helping our faculty, students, and industrial partners to do cutting edge research and development work. While this type of center exits in all major research universities, having both a clean room and materials characterization facilities in one building makes us unique and enables a wide range of research from materials science to device level work. I would also like to thank Deans Wiencek and Weller for their continued support of NREC. I am also grateful for Mr. Robert Tufts and the NREC staff for their dedication and hard work that makes them proud to be involved in interdisciplinary research and development. Kudos to our affiliated faculty members who are engaged in bringing new grants to USF and performing ground breaking research by utilizing the capabilities of the NREC. Your help and suggestions are always needed to make the NREC one of the best centers in Florida. The NREC is also helping many local companies, both small and large, to expand economic development in central Florida region.

The NREC contains specialized shared Center facilities and laboratories for all University of South Florida faculty and students conducting multidisciplinary research. The equipment available in the NREC facilities is maintained and operated by a professional staff whose expertise facilitates quick and innovative solutions to problems presented by researchers. The professional staff also provides intensive training to researchers, thus enabling the faculty and students to become independent certified users of the equipment. Moreover, the infrastructure and expertise offered at the Center are open for external users from other academic institutions as well as from industry.

The NREC has provided to our exceptional faculty members, talented graduate students, post-doctoral fellows, visiting scientists, and engineers the capability to do cutting-edge research. The state-of-the-art facilities of the NREC have played a pivotal role for our faculty to win prestigious **NSF CAREER** awards, and they also have been named **Fellows** of various scientific societies. The NREC also helps our faculty members to seek research funding from both government and private agencies.

I welcome all our users to explore and participate in the world of *Materials*, *MEMS*, and *Nanotechnology* at NREC. We are committed to giving our users an "unfair advantage" against the competition by utilizing a synergistic combination of state-of-the-art tools, facilities, and personnel.

Staff Spotlight

The NREC Staff is here to help you accomplish your research goals

Ashok Kumar, Ph.D.

Director

Robert Tufts, Assistant Director

Yusuf Emirov, Ph.D.

Metrology Scientist

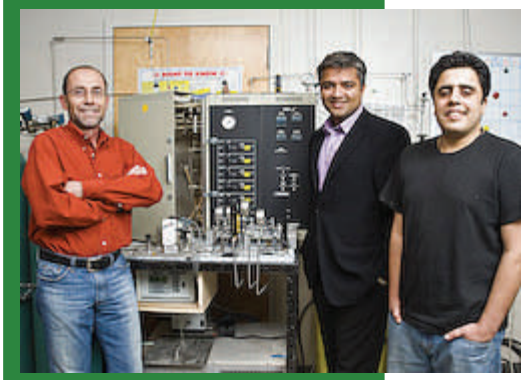
Richard Everly,

Cleanroom Research Engineer

Jay Bieber, Metrology Engineer

Sclafani Louis-Jeune

Office Assistant



John Wolan, Ph.D. (left) Jaideep Rajput (middle) and Syed Ali Gardeza (right)

NREC User Semifinalist

The USF research team (including NREC user Syed Ali Gardeza) that developed a process for converting organic material to fuel, placed fourth in the 2010 Oak Ridge National Laboratory Global Venture Challenge in the category Advanced Materials for Sustainable Energy

The technology is based on a micro-sized silica sphere that is coated with a cobalt-containing catalyst in an "egg-shell" configuration, providing a high surface area for chemical interaction.

Control of the thickness is critical for the process and can be tailored to produce different products — fuels raging from liquid petroleum to diesel and jet fuel that is very clean. The Fischer-Tropsch based process uses carbon monoxide and hydrogen, and produces fuel and water.

Optical and scanning electron microscopy was performed at the NREC, as well as X-ray Diffraction, for characterization of the catalyst coating.

Veeco NT9100 Optical Profilometer

New Tools

Optical Profilometer Veeco NT9100

Non-contact 3-D surface metrology with sub-nanometer vertical resolution, uses coherence scanning interferometry coupled with dual LED illumination to construct highly accurate, three-dimensional maps of investigated surfaces.

The tool has applications in the areas of MEMS, thin films, optical coatings, solar cells, ceramics, and advanced materials research.

High Resolution Scanning Electron Microscope

Hitachi SU-70

HRSEM uses a Schottky field emission source to produce a high resolution image (1nm at 15kV) for precise metrology of samples. The tool will also be fitted with a system to enable electron beam lithography, which will be capable of producing patterns with fine line width.

Advisory Board Partners

John Bumgarner, Ph.D.
Director, Micro Science and Engineering Laboratories, SRI International

Joseph D. Cuiffi, Ph.D.
Principal Investigator
Draper Laboratory

Ronald J. Gutmann, Ph.D.
Professor Emeritus, RPI

Ken Heffner, Ph.D.
Engineering Fellow, Electronic Systems and Engineering Applications
Honeywell Aerospace

Damon Hooten
Systems Development Lead, Consellation Technology Corp.

Thomas J. Koob, Ph.D.
Chief Scientific Officer
MiMedx, Inc.

Sergei Ostapenko, Ph.D.
Ultrasonic Technologies

Penelope T. Salmons, MPA
General Manager, Rosseter Nano Composites

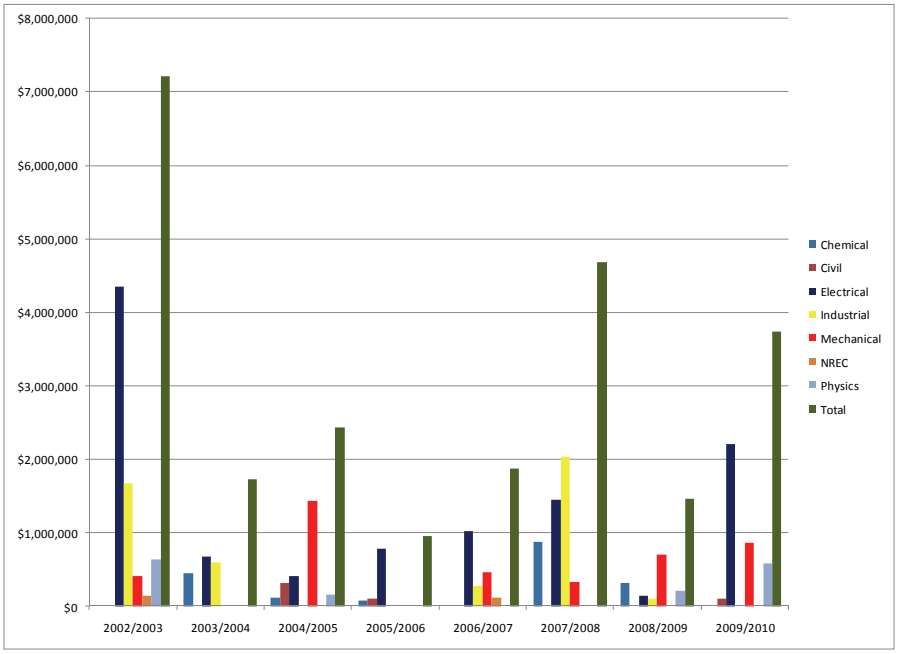
Xueji Zhang , EMBA, Ph.D.
Sr. Vice President of Science, World Precision Instruments, Inc.

Research/Grants

The NREC has helped faculty users to bring in many federal grants by supplying essential tools used in research. The graph at right shows National Science Foundation grants won by faculty users over the last eight years broken down by department.

Other funding agencies include:

- United States Department of Energy
- Florida Energy Systems Consortium
- H. Lee Moffitt Cancer Center & Research Institute
- Florida Department of Health (Bankhead-Coley Cancer Research Program)
- Alfred P. Sloan Foundation
- Grant Opportunities for Academic Liaison with Industry (GOALI)
- Florida Education Fund McKnight



Affiliated Centers

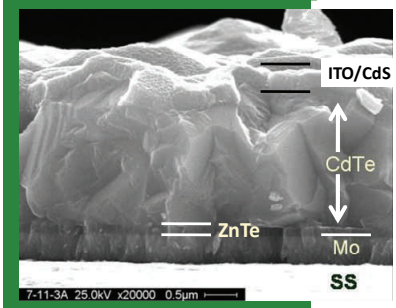
USF Nanomedicine Research Center - An interdisciplinary group of faculty and staff that conducts research on the application of nanoengineering methods and materials to the development of novel, highly effective and useful therapies and diagnostic methods for human diseases.

Florida Advanced Technological Information Center - An NSF-ATE Regional Center for Advanced Technological Education. Aims to be the go-to organization for manufacturing and advanced technical education, as well as resources supporting the high performance skilled workforce for Florida's manufacturing sectors.

USF Florida Center of Excellence for Biomolecular Identification and Targeted Therapeutics (FCoE - BITT)
A multi-purpose lab providing equipment, custom services, consultation and training for biological and interdisciplinary projects (biology, with chemistry and biomedical, chemical and electrical engineering components).

Clean Energy Research Center - Conducts fundamental investigations into new environmentally clean energy sources and systems (hydrogen, fuel cells, solar energy conversion and biomass utilization).

Student Profiles



SEM image of CdTe solar cell cross section showing layer composition.

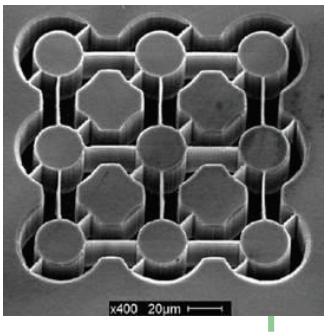
"The NREC has been invaluable to my research, I cannot imagine performing characterization without the capabilities offered at the NREC" - Deidra Hodges, Ph.D.

Deidra Hodges, Ph.D. - Originally from New Orleans, Deidra was displaced by Hurricane Katrina to the Tampa Bay area. She decided to fulfill her desire for a Ph.D. by attending USF and working with Dr. Ferekides on development of CdTe Thin Film Solar Cells on Flexible Foil Substrates. Deidra used many of the Metrology tools in the NREC to investigate her samples, including AFM, SEM, and XRD (see image, left).

She recently completed her degree and has accepted a permanent position at Southern Polytechnic State University in Marietta, GA. As Assistant Professor in the EE department, she will be busy teaching classes on semiconductors and circuits, writing proposals, and building a research lab specializing in thin films and materials for solar applications.

Deidra also holds Masters and Bachelors degrees in EE from Columbia University and a Bachelors in Physics from Dillard University. She worked in industry for IBM (programming flight computers for the space shuttle) and Lockheed Martin before starting her own computer consulting company.

Mingke Xiong, MSEE - Mingke worked for the NREC as a student assistant primarily in the cleanroom. She also worked with Dr. Jing Wang to fabricate MEMS resonators using Silicon-On-Insulator (SOI) technology. Such resonators have applications in filters, as a result of high-frequency operation and high Q factor, increasing selectivity. During her research, she became very proficient with cleanroom processes such as oxidation furnace operation and photolithography as well as other techniques including metal deposition and metrology.



After completing her Masters degree in Electrical Engineering, Mingke is now working in research and development for AEM, Inc. (San Diego, CA) producing multilayer inductive components and other passive devices.

Mingke credits her experiences at the NREC with helping secure her job, as much of her interview was related to fabrication and lab protocols.

Education

NREC has expanded the educational component of the mission by increasing outreach to students and the community. Some of the programs and activities in the last year include:

Laboratory support and development of a new course "Characterization of Materials", taught by Professor John Wolan.

Laboratory support of a new Masters-level, interdisciplinary degree program in Materials Science and Engineering.

Facility tours of NREC during USF Annual Engineering EXPO to high-school students and the general public.

Research assistance to Nathaniel Moura, a 3rd grader at W.B. Dickenson Elementary School, for his winning entry in the Hillsborough Regional Science and Engineering Fair.

Evaluation of final project presentations Nanotechnology in Aviation and Space for the International Baccalaureate program at Robinson High School.

Bring Your Son/Daughter To Work Day: two presentations and tours were given to the eighteen participants who were children of USF staff and faculty.

Graduate Student Users

Faculty Spotlight

Shekhar Bhansali, Ph.D.
USF Dept. of Electrical Engineering

Ph.D. from Royal Melbourne Institute of Technology in 1997. Research areas of interest: bio-MEMS, nanostructures, micro-actuators and integrated systems.

The research that is performed in Dr. Bhansali's group is highly dependent on the facilities and equipment of the NREC, both for fabrication and characterization of devices. Since MEMS is at the micro scale, many devices are fabricated using optical photolithography in the NREC cleanroom.

Integration of biological aspects, such as sensing changes in bio-impedance or implantable micro-needle arrays (image at right) for diagnostics and drug delivery, introduce novel and interdisciplinary elements which add to the potential impact to society.

http://mems.eng.usf.edu/

Implantable silicon micro-needle array

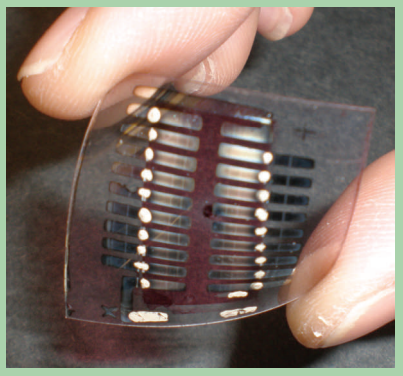
Xiaomei Jiang, Ph.D.
USF Dept. of Physics

Ph.D. from University of Utah in 2004. Research areas of interest: organic semiconductors, quantum dots with semiconducting properties, miniature and integrated solar arrays.

Dr. Jiang's research centers on investigation of the optical and electron transport properties of next generation semiconducting materials. Applications of these materials utilize optoelectronic properties at the nanoscale to provide power for MEMS devices and can be scaled up for integration into the windows of buildings.

Material deposition and evaluation is performed in the lab, however the NREC is used for photolithographic patterning and metrological tools including the AFM, SEM, and TEM.

http://shell.cas.usf.edu/~xjiang/



Organic solar array semi-transparent window

Industry Spotlight

DRAPER LABORATORY

Joseph Cuiffi, Ph.D.
Ph.D. From Penn State in 2004

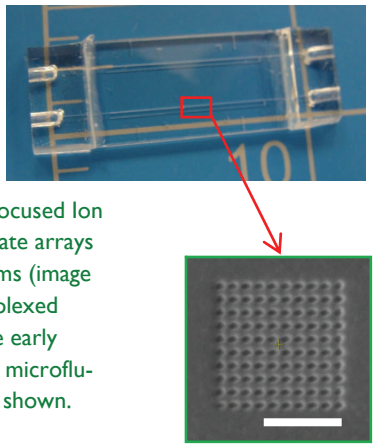
Primary Investigator at Draper Bioengineering Center, Tampa FL

Work at Draper centers around three types of bio-medical devices: Advanced Molecular Bio Sensors, Microfluidics Sample Preparation, and Advanced Cell Culture with Microfluidic Devices. Creation of these devices entails the use of the cleanroom at the NREC, in particular the use of the optical lithography and chemistry bays.

Having these facilities on the USF campus in a multi-user capacity allows Draper to utilize their resources for other equipment, rather than duplicating the cleanroom environment dedicated for their purposes.

Also at the NREC, the Focused Ion Beam tool is used to create arrays of nano-sized holes in films (image at right) for use as multiplexed biomarker sensors in the early detection of cancer. The microfluidic interface chip is also shown.

This project is in collaboration with Dr. Subhra Mohapatra from the College of Medicine, Dept. of Molecular Medicine.



Microfluidic nano-hole array sensor (scale bar 2µm)

Nanotechnology Research and Education Center

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We're on the Web
http://nrec.eng.usf.edu

Conferences and Seminars

The NREC helped organize and contribute to two events earlier this year. The first was a seminar given by Dr. Thomai "Mimi" Panagiotou, CTO of Microfluidics International, a company based out of Massachusetts that specializes in manufacturing tools for high shear, fluid-based materials processing.

The seminar topic was "Microfluidics Practices of Nanotech Post-Processing for Chemical and Energy Applications and Life Sciences/ Nutraceuticals." Tool applications include particle size reduction, nanoemulsions, cell disruption, and bottom-up particle creation.

The second event was the Nano-Bio Collaborative Conference, sponsored by the USF Nanomedicine Research Center, NREC, and Draper Bioengineering Center, among others. Conference topics included nanotherapeutics, nanosensors, tissue engineering, and stem cell technology.

The two-day conference included presentations from twenty speakers and a poster session. Attendance at the event was (interdisciplinary) with a large number of attendees from Industry and Academia. (networking opportunities)

Donations

The Nanotechnology Research and Education Center is a vital component in the development or cutting-edge research. Your financial contributions supplement state and grant funding, and make an enormous difference in our efforts to further research capabilities and improve our infrastructure. Equipment donations are also encouraged. All gifts are tax deductible. If you have any gift/tax questions please contact Brett Woods, Director of the USF's College of Engineering Development Office at (813) 974-9199 (or e-mail, bwoods@usf.edu). Thank you for your generous contribution to the USF NREC!

Ashok Kumar, Director, NREC

Yes, I want to donate to the University of South Florida's Nanotechnology Research and Education Center.
My donation is:

$50 $100 $250 $500 $1000 Other

Please make checks payable to the "University of South Florida Foundation" and note on the check and in your cover letter that your gift is for the Nanotechnology Research and Education Center (NREC). Mail it to: College of Engineering ENB 118, University of South Florida, 4202 E. Fowler Ave., Tampa, FL 33620-5350

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