Oklahoma NSF EPSCoR Research Connection

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Oklahoma's Strength in Biofuels Research Is Focus of Next EPSCoR Proposal

Submitted by: Ms. Shelley D. Wear, Special Programs Coordinator, Oklahoma EPSCoR

This past January, Oklahoma submitted an application for continued support from the National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR) Research Infrastructure Improvement (RII) Program. The initial proposal preparation began in March 2007, when Dr. James Wicksted, Oklahoma EPSCoR Associate Director and principal investigator on the application held a plenary session to encourage Oklahoma scientists to share their ideas for a new state science theme. Researchers were asked to submit ideas from NSF scientific thrust areas that exemplified Oklahoma strengths consistent with the state's science and technology plan, otherwise known as Economic Development Generating Excellence (EDGE).

> ***"Our scientific community is to be commended for putting together such a large number of high quality proposals."***

At this plenary session, 42, five-minute presentations were made. From the 42 presentations, scientist formed partnerships and 18 multi-campus, multi-investigator research groups emerged.

On April 27, the Oklahoma EPSCoR Advisory Committee heard 18 white paper presentations describing potential research theme projects for the 2008 NSF EPSCoR RII application.

Wicksted stated, "Our scientific community is to be commended for putting together such a large number of high quality proposals."

After difficult deliberation, the Oklahoma EPSCoR Advisory Committee narrowed the search to one research theme project for inclusion in Oklahoma's proposal. The project selected was "Building Oklahoma's Leadership Role in Cellulosic Bioenergy". This is a multi-institutional project lead by Dr. Raymond L. Huhnke, Oklahoma State University (OSU) Professor of Biosystems and Agricultural Engineering. The proposed project will capitalize on Oklahoma strengths in genomics to explore the mechanisms of biomass development, investigate efficient microbial conversion of biomass to biofuels and develop new processes to make this conversion of biomass more efficient.

If funded, the RII proposal could result in up to three million dollars a year for five years, further strengthening Oklahoma's biofuels/bioenergy research initiative and implementation of outreach programs designed to broaden participation in the STEM fields.

Ms. Shelley D. Wear, EPSCoR Special Programs Coordinator, will lead the outreach efforts geared to K-12 and postsecondary students and faculty and the general public. Other initiatives in the proposal aim to foster partnerships with industry and the state's science museums.

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Inside this issue:

EPSCoR Scientist Discovers New Plant Virus

Submitted by: Dr. Tracy Feldman, Postdoctoral Fellow, The Samuel Roberts Noble Foundation

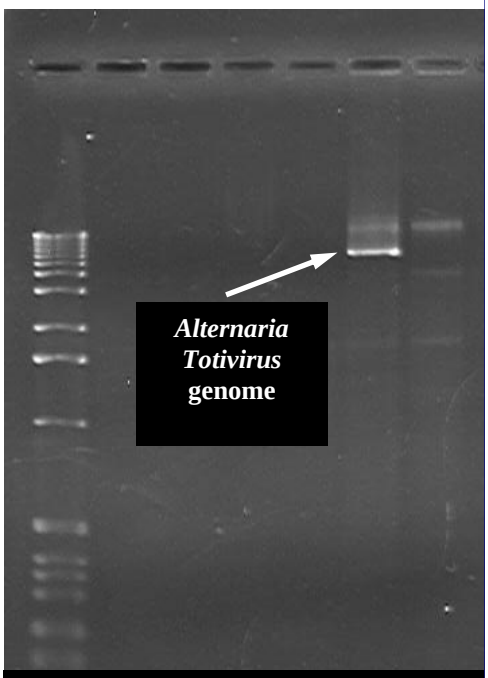
In year two of a mycovirus diversity study funded by the NSF EPSCoR RII grant, Dr. Tracy Feldman, a Noble Foundation researcher, has discovered a totivirus in the fungus *Alternaria alternate* that is the same or closely related to a virus discovered in 2006. This fungus commonly occurs in association with plants on the Tallgrass Prairie Preserve (TGPP) in Pawhuska, Oklahoma and elsewhere. It is known to cause leaf spot diseases in some plants, but also can occur on plants without producing detectable symptoms. NSF EPSCoR and Noble Foundation funding enabled Feldman to make the discovery, in addition to 18 other fungal viruses (on diverse fungal hosts) discovered in year one of the grant.

Shown above: A photograph of *Alternaria alternate*.

Photo courtesy of Dr. Tracy Feldman, The Samuel Roberts Noble Foundation

According to Feldman the fact that he discovered the same virus in two different years is significant because, "we may be able to characterize mycovirus diversity in a locale. As of last year, it seemed as if almost every virus I found was different from all of the others." This means that fungal virus diversity could be very high on the TGPP, but it may yet be possible to find out how many species of fungal viruses reside in one area. There is no reason to believe that mycovirus diversity wouldn't follow patterns observed in other organisms, with a few common species and many rare ones."

Feldman and other EPSCoR-funded scientists continue their quest to find novel viruses and study their positive and negative impacts on plants and fungi in Oklahoma and the region. For more information on this discovery please contact Dr. Tracy Feldman, at tsfeldman@noble.org or Dr. Ulrich Melcher, EPSCoR Plant Virus Biodiversity and Ecology Project Coordinator at : umecher@biochem.okstate.edu.



Above: Agarose gel run with dsRNA (double-stranded RNA) extracted from several Alternaria individuals. The vertical lane with the arrow next to it contains dsRNA from the isolate with the virus, and the band is the genome of the virus.

Photo courtesy of Dr. Tracy Feldman, The Samuel Roberts Noble Foundation

Collaborative Research Aids Understanding of Virus Evolution

Submitted by: Dr. Adam Zlotnick, Associate Professor of Biochemistry and Molecular Biology, University of Oklahoma Health Sciences Center

Does evolution select for thermodynamic properties? This is one of the questions asked by Mr. Chao Chen, a graduate student from the lab of Dr. Bogdan Dragnea in the Department of Chemistry at Indiana University, who spent the month of October studying the thermodynamics of virus assembly with Dr. Adam Zlotnick, Associate Professor of Biochemistry and Molecular Biology at the University of Oklahoma Health Sciences Center in Oklahoma City. Chen and Zlotnick investigated two closely related plant viruses, the cowpea chlorotic mottle virus (CCMV) and the brome mosaic virus (BMV). Their studies revealed that the two viruses are structurally similar sharing 70% identity in their coat proteins. However, the typical hosts of the brome grass and cowpeas prefer very different environments. Brome grass grows in cool environments whereas cowpeas are cold sensitive. In preliminary experiments it is evident that CCMV assembles fine at room temperature while BMV assembly is most active in the cold. The difference in temperature dependence indicates that the thermodynamic signatures of the assembly reactions are likely to

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Oklahoma Researchers Investigate Ecology and Physiology of a New Virus in the Tallgrass Prairie

Submitted by: Dr. Richard Nelson, Professor, Plant Biology, The Samuel Roberts Noble Foundation

In the last EPSCoR Connection it was noted that approximately 30% of the plants sampled in the Oklahoma Tallgrass Prairie Preserve (TGPP) contain virus-like particles or nucleotide sequences similar to those of known viruses. While the survey of virus-like particles and sequences continues, some of the scientists within the NSF EPSCoR-funded project are verifying that these elements and sequences do, in fact, represent infectious viruses.

Dr. Byoungeun Min, a joint postdoctoral fellow in the laboratories of Dr. Rick Nelson at the Samuel Roberts Noble Foundation and Dr. Jeanmarie Verchot-Lubicz at Oklahoma State University, analyzed tissue from *Asclepias viridis* (a species of milkweed) previously shown to contain a nucleotide sequence related to a particular group of plant viruses, the tymoviruses. Through various biological and molecular analyses, Min determined that infectious virus was present in the samples. It then was important to determine the range of plant species infected by the virus and the extent and persistence of infection in the *A. viridis* TGPP population. This would allow researchers to better understand how viruses function within natural rather than man-made (e.g. crop production) habitats.

Experiments were designed to determine the range of plant species susceptible to this virus. In addition, the presence of this virus over time and space in *A. viridis* through the spring and summer of 2007 was investigated. Initial analyses indicate the tymovirus is present in multiple plant species within the TGPP, including species both closely and only distantly (e.g. a grass species) related to *A. viridis*. In addition, the virus was present throughout the sampling period in many *A. viridis* plants covering a large area of the TGPP.

Considering the extent of the tymovirus infection in *A. viridis* in the TGPP, it will be important to determine if this infection is detrimental to seed production by these plants. It is possible that the infection may provide benefits to the plant (e.g. resistance to other stresses) that outweigh costs, such as a minor decrease in seed production per plant. In addition, tymoviruses have been shown to cause significant damage to agricultural and ornamental crops. The presence of this tymovirus in extremely divergent species in the TGPP indicates it has the potential to infect crop species important to Oklahoma. Our findings will allow researchers and production specialists to function proactively, rather than reactively, in identifying methods to protect our crops from this virus.

Above: *Asclepias viridis*, also known as milkweed, is a host to a novel virus in the genus tymovirus.

Photo courtesy of Vijay Muthukumar, Oklahoma State University.

COLLABORATIVE RESEARCH *(continued from page 2)*

be radically different with assembly of one virus driven by entropy and the other by enthalpy. This discovery is important for understanding the natural diversity of viruses and their ability to adapt to new environments.

EPSCoR Plant Virus Biodiversity and Ecology Project Coordinator, Dr. Ulrich Melcher comments on the importance of this research, "Plant virologists have long been studying the pathways of virus evolution with only occasional understanding of the selective pressures determining the pathways taken. This work, tying climatic influences, in this case temperature, to the structure of capsid proteins is a major contribution to understanding how climatic forces influence virus evolution."

These viruses also are interesting from the standpoint of nanotechnology, linking the two Oklahoma EPSCOR science themes. Building nanostructures one at a time would be difficult and time consuming. Viruses are experts on self-assembly. Their assembly can be diverted to generate novel structures and to encapsidate nanoparticles. This redirected assembly was also investigated during Chen's visit to Oklahoma.

Says Dr. Zlotnick, "By learning how viruses work, we may learn how to take advantage of them. The work that Mr. Chen started with his visit to Oklahoma will be the subject of further collaboration between my research group and Dr. Dragnea's group in Indiana."

JEOL 2010F at OU Exceeds All Other Electron Microscopes in the State

Submitted by: Dr. Matthew B. Johnson, Professor, Physics and Astronomy, University of Oklahoma

The long anticipated installation of the JEOL 2010F Field Emission Transmission Electron Microscope (FE-TEM) at OU has finally entered its operational phase (Figure 1). Exceeding the resolution of all other electron microscopes in the state by an order of magnitude, this microscope is capable of visualizing images that penetrate to the level of atoms and molecules, with magnification of up to 8,000,000 times. This microscope, with a new acquisition value of $1.5M, provides a means of visualizing the interrelationships of atoms and conducting nanochemistry by means of analyzing interactions between objects with its fine beam of electrons.

As nanotechnology strives to miniaturize components down to the level of interactions between single and multiple atoms, FE-TEM has become the versatile *eyes* into the nanoworld.

Using electrons rather than photons (light) to image samples, TEMs are routinely used to see through ultra-thin samples. What is new about this microscope is that the electrons are all in phase (like a laser) and its coherent beam can be converged to a size that is 1/10 that of our current conventional electron microscopes. Under ideal conditions in scanning mode (called scanning TEM or STEM), images clearly resolve Si dumbbells in 110-oriented silicon (Figure 2) —a useful real-life benchmark for such microscopes. As materials reach nano-dimensions of complexity, increasingly sensitive microscopes are being developed to facilitate the breakthroughs of the future, requiring a continuing investment in state-of-the-art technology.

Figure 1 above: OU's JEOL 2010F is located in the basement of the George Lynn Cross Hall.

Physical properties of nanomaterials depend on their structural relationships, so scientists are trying to detect their chemical structure down to the interatomic level. Since the FE-TEM generates a fine particle beam, the nanochemistry of a superthin material may be analyzed by energy lost as the electron beam passes through a sample, or through X-rays produced by electron substitutions. Plans are underway to acquire an energy-dispersive X-ray spectroscopy (EDXS) system to identify elements in the microscope. The nature of bonds between atoms may be sensitively probed using a planned electron energy loss spectroscopy (EELS) system. Such state of the art FE-TEMs are capable of measuring crystalline properties down to the atomic scale, and resolve chemical properties down to the nanoscale. The only catch — samples need to be at most 10s of nanometers thick (just a few atoms), must be stable in a vacuum and an electron beam, and understanding the images may require computer analysis. This microscope is the most sensitive electron microscope in the state. Since it images atoms, this microscope can also image even the slightest displacement due to changes in temperature, magnetic and electrical fields, wind, vibrations and atmospheric pressure.

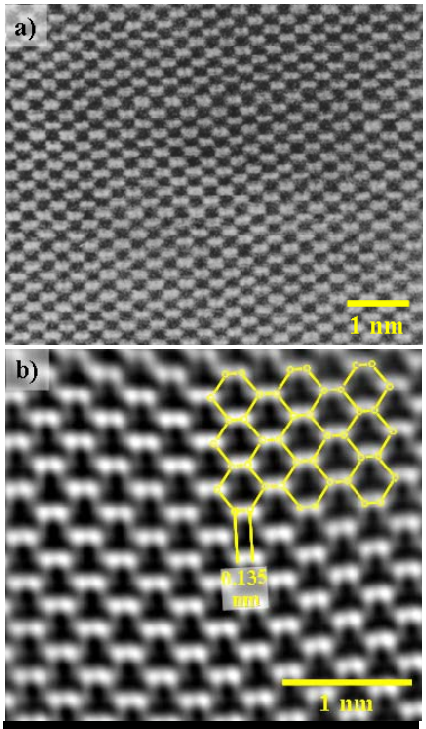


Figure 2 STEM images of Si dumbbells in 110-oriented silicon. (a) is a raw image showing the dumbbells. (b) is a low-pass filtered, expanded image with atomic positions labeled.

OU's JEOL 2010F was obtained using a combination of sources, most notably Oklahoma state and National Science Foundation funds from OK-NanoNet an NSF-EPSCoR center and C-SPIN an NSF Materials Research Science and Engineering Center (MRSEC).

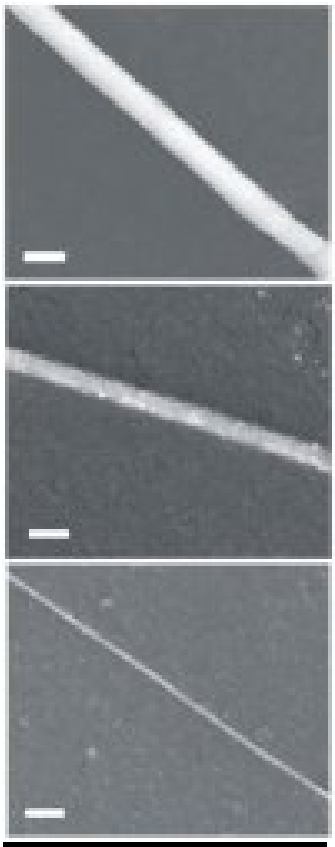
For more information, see the website of the Samuel Roberts Noble Electron Microscopy Laboratory at URL: http://www.microscopy.ou.edu/ , or contact Greg Strout at gstrout@ou.edu, 405-325-4391. A page describing the JEOL 2010F is located at http://www.microscopy.ou.edu/jeol-2010f.shtml.

DENA Dials Up Diameter-tunable Nanowires

By: Dr. James Tyrrell, Editor, NanoTechWeb.org

Dip into the literature and you'll find a number of techniques for controlling nanowire diameter, most of which require two processing stages: one to grow the nanowire and another to make the connection with the host device. Scientists at Oklahoma State University, US, claim that they can complete the task in a single step and are using the method to probe intracellular signalling pathways.

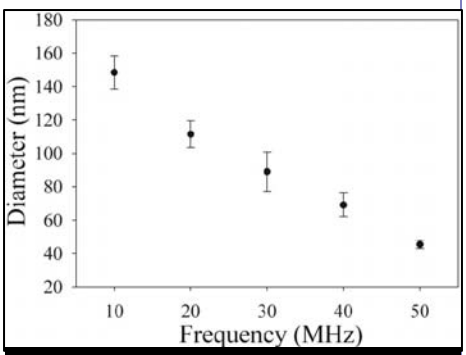
Dubbed directed electrochemical nanowire assembly (DENA), the process involves passing an alternating voltage between sharp electrodes immersed in concentrated salt solution. The waveform induces electrochemical deposition between the two electrical contacts and gives rise to a perfectly formed nanowire. To control the diameter of the nanowire, researchers simply dial up the appropriate frequency on a signal generator connected to the setup's voltage amplifier – the higher the frequency, the smaller the diameter.



Indium nanowires

The process involves time-varying diffusion fields and team leader Bret Flanders thinks that the work is one of the first experimental studies of non-stationary dendritic solidification. "It is the non-stationary aspect of this approach that makes the control over diameter possible," he told *nanotechweb.org*.

Only square waveforms readily induce the growth of nanowires. "It takes a certain amount of time to transport the cations to the solidification front during each negative half-cycle of the waveform. Our leading hypothesis is that the square waveform supplies the full amplitude of the applied voltage during the entire half-cycle, whereas the sinusoidal and saw-tooth waveforms do so only during the peak of a half-cycle," said Flanders. "In essence, a square waveform of a given frequency supplies the maximum voltage for longer periods of time than other waveforms, so the square wave is more efficient at inducing deposition."



Diameter data

Researchers are putting DENA to the test by growing metallic nanowires at targeted sites on biological cells. "Our aim is to study intracellular signalling pathways by using the wires to deliver small voltages to the cell and stimulate ion fluxes," revealed Flanders. "We expect that this technique will allow electrophysiological measurements to be made with enhanced spatial resolution."

After its success at making nanowires out of indium and gold, the group is now working on expanding the range of materials that may be deposited using DENA. "It would be interesting to produce wires composed of alloys, semiconductors or conducting polymers," commented Flanders. "We have spent the last few weeks setting up for these studies and are looking forward to obtaining preliminary results within the next month."

Researchers presented their work in *Nanotechnology*.

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Editor's note: Dr. Bret Flanders is an Assistant Professor in the Department of Physics at Oklahoma State University.

RII PROPOSAL
(continued from page 1)

Huhnke's research group includes a total of 32 scientists from various departments at OSU, the University of Oklahoma, and the Samuel Roberts Noble Foundation. The proposal's senior personnel are listed by campus:

Oklahoma State University

Dr. Raymond L. Huhnke, Department of Biosystems and Agricultural Engineering; Dr. Yanqi Wu, Department of Plant and Soil Sciences.

University of Oklahoma

Dr. Lance Lobban, School of Chemical, Biological and Materials Engineering; Dr. Jizhong Zhou, Institute for Environmental Genomics.

Samuel Roberts Noble Foundation

Dr. Kiran Mysore, Plant Biology Division.

Six additional tenure-track faculty positions are expected to be established in the course of the grant.

OK EPSCoR Women in Science Conference Inspires Young Students

Submitted by: Dr. Amy McGovern, Assistant Professor, School of Computer Science, University of Oklahoma and Conference Chair

How do we inspire more young women to choose careers in science, engineering, and mathematics? On February 5, 2008, Oklahoma EPSCoR reached out to over 500 students from 7th through 12th grade with the goal of inspiring more women to choose science careers.

This year's annual Women in Science Conference focused on "Discovering New Frontiers for Women in Science" and was sponsored by Oklahoma EPSCoR, Oklahoma State Regents for Higher Education, the National Science Foundation and Science Museum Oklahoma (SMO). SMO is a Smithsonian affiliate and the state's largest science museum. SMO's vast collection of hands-on science exhibits served as the backdrop for the conference site for a second year and the conference drew students, as well as math and science teachers from as far away as Tulsa, Lawton and Madill.

The conference focused on successful women in science. The students began their morning with a captivating keynote speaker. Dr. Kiri Wagstaff, a Senior Researcher at NASA's Jet Propulsion Laboratory, enthralled the participants with stories of growing up in a very small town in Utah with fewer than 500 people and how she became a successful scientist at NASA/JPL.

Fifteen female scientists, engineers, and college students sat on three interactive panels and each talked about her personal experiences at succeeding in college and in science. The panelists reflected careers in emerging interdisciplinary frontiers of science: the human body, the environment, and applied and physical sciences. By exposing the students to a wide variety of career choices, they began to see how broad a science career could be.

Participants explore a student-designed robot at the Botball exhibit during the educational outreach and recruitment fair at the Women in Science Conference February 5, 2008.

A scavenger hunt encouraged the students to interact with each other and booth representatives during an educational outreach and recruitment fair that featured over 30 college recruiters, grant programs, and non-profit organizations. Students designed their own questions about college and how to chart their career courses. They were encouraged to ask personally meaningful questions.

A teacher's lounge provided math and science teachers a place to network with their peers and also obtain information about professional development and summer research opportunities for themselves, as well as resources for their students.

The day wrapped up with Ms. Cari Lousch, Field Coordinator for Student Preparation at the Oklahoma State Regents for Higher Education, who helped students plan their high school classes for success in college.

"The excitement level was infectious. As the students learned more about science careers, they began to envision themselves as scientists and engineers and began asking questions of each panelist. By the end of the day, they went home full of ideas about future careers," said Dr. Amy McGovern, Assistant Professor in the School of Computer Science at the University of Oklahoma and the chair of this year's EPSCoR Women in Science Conference.

As William Arthur Ward said, "If you can imagine it, you can achieve it. If you can dream it, you can become it." EPSCoR's Women in Science Conference helped these students to imagine themselves in science careers.

Students interacted with 30 Oklahoma college and university recruiters, grant program and non-profit organization representatives during the event which aimed to broaden participation of women in the fields of science and engineering and higher education.

Upcoming Events 2008

March 6-7	**NanoFocus & Oklahoma NSF EPSCoR Annual State Conference 2008 (*featuring the ONI Undergraduate Nanotechnology Symposium)*,** Cox Convention Center, OKC
March 14	**Donald W. Reynolds Oklahoma Governor's Cup Statewide Collegiate Business Plan Competition** – Written Business Plan Submission Deadline, i2E, Inc., OKC
March 31	**Research Day at the Capitol**, State Capitol, OKC
April 2-3	**Flint Hills Ecology from Top to Bottom: A Retreat at the Nature Conservancy's Tallgrass Prairie Preserve**, Pawhuska, OK & **Konza Prairie Biological Research Station**, Manhattan, KS
April 10-12	**National Conference on Undergraduate Research (NCUR) 2008**, Salisbury University, Salisbury, MD
April 16-19	**American Indian Symposium**, NSU-Tahlequah
April 24	**Donald W. Reynolds Oklahoma Governor's Cup Awards**, OKC
May 16	**NSF Grants Workshop**, Wes Watkins Center, Stillwater, OK

For more information, please visit our website or contact Ms. Shelley D. Wear, Oklahoma EPSCoR Special Programs Coordinator at 405.225.9287 or swear@osrhe.edu.

www.okepscor.org/events.asp

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