Linking South Dakota's Future With Science & Technology

SD EPSCoR Update

Fall 2013

South Dakota Experimental Program to Stimulate Competitive Research

South Dakota EPSCoR Research Infrastructure Improvement Goals:

Photo Active Nanoscale Systems (PANS)

Research focused in four Interdisciplinary Research Groups:

- Noble-metal-enhanced phosphor and sensor composite materials
- Security Printing
- Broad-spectrum organic/inorganic photovoltaic materials and devices
- PANS Catalysis

Technology-Based Economic Development & Entrepreneurship

- Partnering with the Governor's Office of Economic Development (Department of Tourism & State Development) to promote entrepreneurship
- Encourage S&T leadership development
- Support technology entrepreneurship education programs

Partner with South Dakota's Tribal Colleges and Universities

- Develop and implement research infrastructure improvements
- Increase collaborations with other South Dakota universities
- Promote participation in South Dakota's economic development activities

Outreach Activities

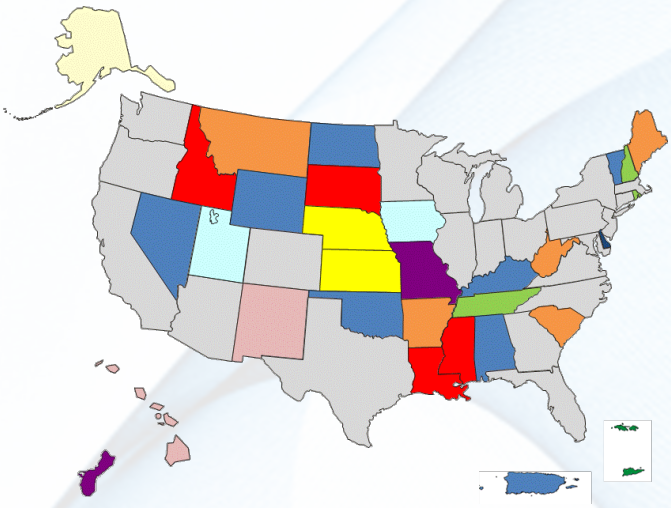
- Raise awareness of SD EPSCoR and its contributions to the state
- Provide research experiences to Tribal College faculty and students
- SD EPSCoR partners with the SD Governor's Office of Economic Development, the SD Office of Commercialization, and the SD Board of Regents to create entrepreneurship education programs
- National science & economic development and entrepreneurship conferences held in South Dakota
- Annual Student Research Poster Day held at the Capitol Building in Pierre

The REACH Committee

- Provides leadership to SD EPSCoR
- Promotes understanding of EPSCoR programs and their impact on our state
- Spearheads new policies and resources
- Ensures rigorous merit review processes
- Generates high levels of collaboration
- Keeps EPSCoR responsive to state and regional needs
- Develop and implement the state's first Science and Technology Strategic Development Plan
- Expand graduate education
- Strengthen interdisciplinary and collaborative research in strategic "niche" areas
- Develop the state's research infrastructure
- Support the Governor's STEM-based economic deveopment initiatives
- Members are drawn from South Dakota state government, legislature, higher education and the private sector

What is EPSCoR?

The National Science Foundation (NSF) created the first Experimental Program to Stimulate Competitive Research (EPSCoR) program in 1980. Its success led Congress to expand the program and since 1990 create EPSCoR-like programs in several federal agencies, including: USDA, NIH, DoD, DOE, NASA and EPA.



EPSCoR identifies, develops, and uses a state's academic science and technology (S&T) resources to support its economic growth and promote a more productive and fulfilling way of life for its citizens. EPSCoR acts on the premise that universities, their science and engineering faculty, and their students are valuable resources that can influence a state's development in the 21st century. To achieve this goal, NSF collaborates with state leaders in government, higher education, and business to create partnerships that can bring lasting improvements to the state's academic research infrastructure and increase its national research and development (R&D) competitiveness.

SD EPSCoR

RESEARCH. EDUCATION. ECONOMIC DEVELOPMENT.

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SD EPSCoR Update - Fall 2013

In this Issue:

Cover Photo: Rui Peng prepares an experiment to split water into hydrogen and oxygen using sunlight. Read the story on Page 6.

Phillip Huebner, Director of STEM Partnerships

Considering its population and geographic location, South Dakota is unique in having a vast and highly regarded network of Science, Technology, Engineering, and Mathematics (STEM) activities from educational endeavors to state-of-the-art research projects. The Office of STEM Partnerships, led by Phillip Huebner, focuses on consolidating these programs to help build a 'pipeline' of future South Dakota scientists, engineers, mathematicians, and technicians to meet the ever-increasing STEM workforce demands in South Dakota.

Since the initiation of the Office of STEM Partnerships eight months ago, efforts have been made to establish a centralized registration system for all STEM events in the state. A centralized registration system serves two key purposes:

- It provides "one stop" shopping with a transparent registration process for all programs regarding the students, teachers, and parents interested in involving their children in these events; and,
- It provides the ability to follow students in their STEM endeavors, highlighting their accomplishments and allowing them to use this information for college admission, scholarships, and ultimately a position in the company of their choice.

South Dakota also has a very rich and diverse population, which can bring strength and new perspectives to our growing STEM infrastructure. To address this, the Office of STEM Partnerships is engaged in addressing the diversity needs of the state from K-12 to higher education.

Meeting this challenge involves promoting and supporting STEM programs and activities in rural, economically disadvantaged, and minority serving areas across the state. This is followed with supporting the challenges higher education faces in retaining and graduating these students who have chosen a STEM career.

Through a partnership with SD EPSCoR, a diversity consortium is currently being designed to meet the needs of these underrepresented students as they pursue their degrees. The consortium includes representation from all South Dakota schools of higher education including tribal, private, technical schools, and Regental schools. The consortium will also involve industry, emphasizing that industry will be the next path these students are working toward. Including industry with the consortium allows them to be actively engaged with the students in their educational process.

South Dakota has the resources and the population to revitalize the pioneering spirit we had 200 years ago and become a leader in STEM in the 21st century.

Three grad students to represent SD EPSCoR at National EPSCoR Conference in Nashville, Tenn.

SD EPSCoR hosted its annual All Investigator Meeting this spring at The Cedar Shore Resort in Chamberlain, S.D. The meeting allows the opportunity for faculty, staff and students to network, share their research and attend educational workshops.

This year's meeting, however, was made a little more interesting by adding a competition. Students presenting research posters competed for the chance to be selected to attend the National EPSCoR Conference in Nashville, Tenn., with travel expenses paid by SD EPSCoR.

With the competition in place this year, 18 faculty members critiqued three to five student posters each based on content and presentation quality. The three students with the highest scores were invited to attend the national conference in Tennessee this November.

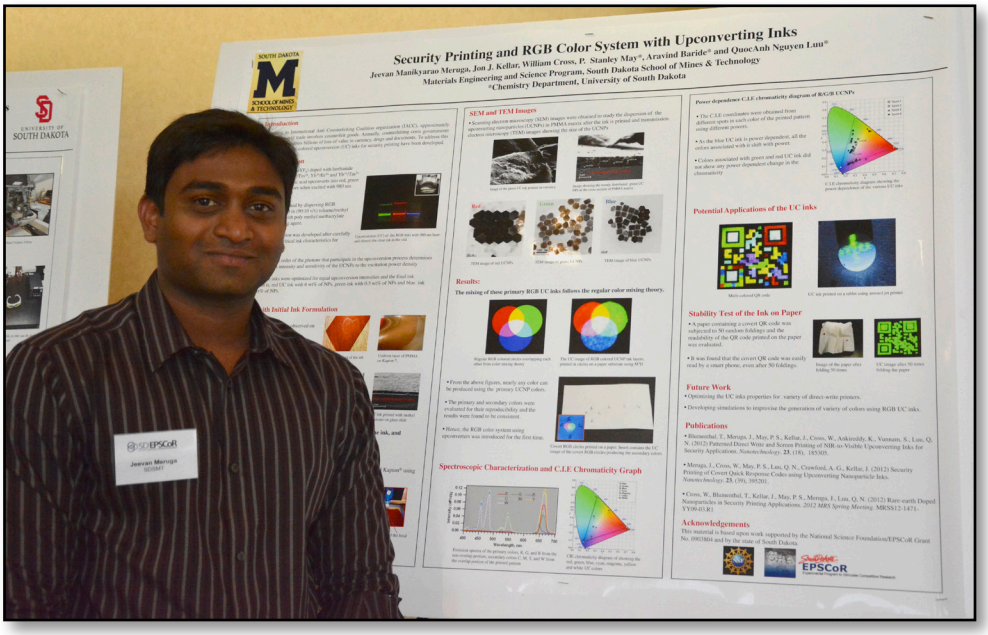
"As I go through and talk to students they have really professional looking posters, good presentations and every year they show they've done a lot in 12 months," said University of South Dakota Professor Mary Berry. "I'm really impressed with them."

Each of the students and their research are supported by the SD EPSCoR "Beyond the 2010 Initiative" Research Infrastructure Improvement award, which receives $20 million over five years from the National Science Foundation.

The student researchers that will be representing SD EPSCoR are: Olusegun Adebanjo from South Dakota State University, and Jeevan Meruga and Srujan Mishra, both from South Dakota School of Mines and Technology.

"I was shocked and surprised to realize that I have been selected to represent South Dakota at the national conference," said Adebanjo. "I could remember that I was so elated because I never expected it."

The national conference will showcase the research contributions of the nation's EPSCoR jurisdictions, while highlighting opportunities to use science and engineering research for job creation, entrepreneurship, external engagement and innovation.



Jeevan Meruga, a graduate student at SDSMT, stands in front of his research poster at the anual poster session during the All Investigator Meeting, May 29. Meuga will attend the National EPSCoR Conference this fall with graduate students Olusegun Adebanjo, SDSU, and Srujan Mishra, SDSMT.

Students will be able to learn from the industry experts as well and also present their research during the National EPSCoR Poster Session at the conference.

"I look forward to meeting other research students and having an insight into their research investigations," said Adebanjo. "This gives me an idea of future research directions."

Attending the conference will also provide the students with skills that will benefit them both long-term and short-term.

"It's a great chance for them to practice how to communicate science to an audience that not only has scientists in it, but also legislators, business people, other students and the news media," said James Rice, SD EPSCoR project director.

Rice says they will also learn the importance of being advocates not just for their own research, but for the science community in general.

"They represent South Dakota and show the U.S. the quality of research that is going on in our universities," said Rice.

2013 National EPSCoR Conference

Nashville, Tenn., Nov. 3-7

The national conference will showcase the research contributions of the nation's EPSCoR jurisdictions, while highlighting opportunities to use science and engineering research for job creation, entrepreneurship, external engagement and innovation.

Sessions will include:

- Industry collaborations for STEM workforce development and research
- Broadening participation in STEM
- Role of science and engineering research in pre-college STEM
- Infrastructure building for technology-based business development
- University technology transfer and commercialization
- Regional and national economic development
- America's Science Idol (student competition)

Read more at www.sdepscor.org

Converting sunlight to hydrogen fuel:

Splitting water using photocatalysts

Sunlight is widely regarded as the most abundant energy source on Earth. It is clean, free, renewable, and it depletes no fossil fuels. For these reasons, scientists have spent many years developing ways to convert sunlight into a usable form of energy. Current methods of conversion, however, are inefficient and expensive.

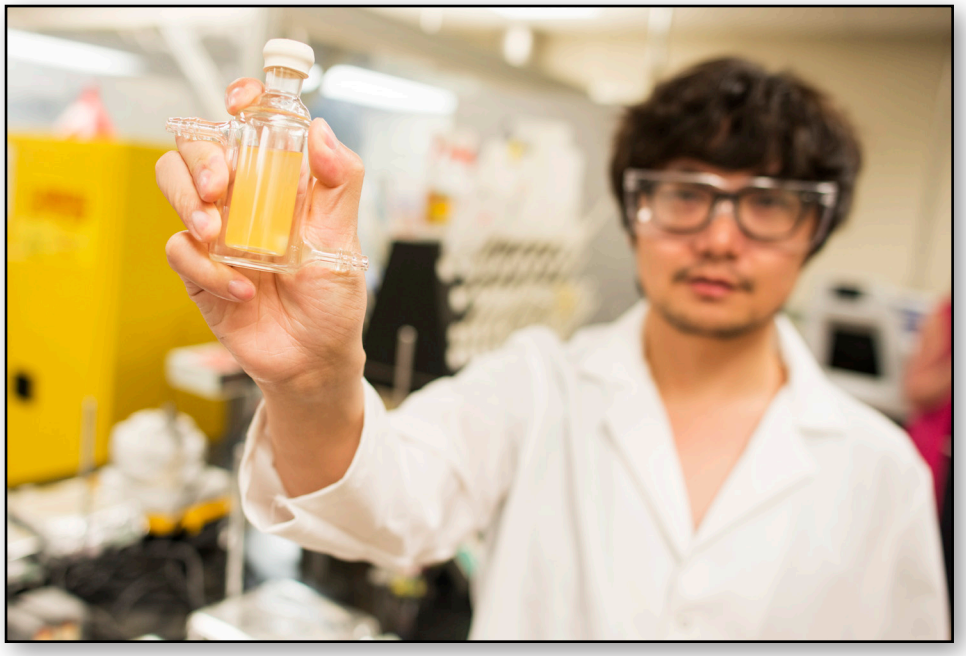
Researchers at the University of South Dakota in Vermillion are working on the next generation of solar energy applications. They have developed a method to use visible light for hydrogen fuel production.

"Hydrogen is considered the ultimate green energy," said Rui Peng, a doctoral student in materials chemistry at USD.

Peng and his research is supported by the South Dakota Experimental Program to Stimulate Competitive Research (SD EPSCoR) "Beyond the 2010 Initiative" Research Infrastructure Improvement award, which receives $20 million over five years from the National Science Foundation.

According to the U.S. Department of Energy, hydrogen fuel is environmentally friendly and can be produced domestically, reducing dependence on fossil fuels. A major challenge for hydrogen fuel is high production costs and is only available at a handful of locations.

Peng uses a process called photocatalysis, the acceleration of a chemical reaction by light, to break down water into its base elements of hydrogen and oxygen.



Rui Peng displays a container containing water and the photo catalyst used to split water into hydrogen and oxygen using sunlight.

This process is not as simple as putting water in sunlight, however. Using visible light to split water has been a challenge because only very few photocatalysts absorb in the visible light region and they are usually inefficient.

Using photocatalysts began many years ago when scientists from Switzerland reported the use of a photocatalyst to split water in the 1980's, said USD Associate Professor Ranjit Koodali.

Koodali, who leads Peng and other students in photocatalyst research, says the researchers demonstrated how the material titanium dioxide, a common pigment found in products such as paints and cosmetics, is capable of working as a photocatalyst.

"This material has an interesting property that allows it to capture sunlight," said Koodali.

Despite its ability to absorb sunlight, certain restrictions of the material have prevented its use in solar energy applications.

"One of the problems of titanium dioxide is that it does not absorb visible light," said Koodali. "That has limited the applications of titanium dioxide based materials for solar energy conversion."

Titanium dioxide only absorbs ultraviolet light, which according to Peng makes up less than five percent of the sun's energy that reaches Earth. Visible light, on the other hand, makes up 45 to 50 percent of the solar spectrum.

"Visible light is a more abundant energy source that we can use from solar energy," said Peng. "That provides us more efficient energy to convert from solar to chemical, which means from solar light to hydrogen fuel cells. "

Researchers made the next step in solar energy applications several decades ago, says Koodali. Scientists have been working with a nanomaterial called 'quantum dots' which are capable of absorbing visible light.

A group of researchers in South Dakota started working with these concepts and applied them to water splitting in 2009, Koodali said.

"We merged these two ideas and

You Tube **Watch the Video**

Visit www.sdepscor.org to watch more on Peng's Research with Catalysts

developed a material that has both quantum dots and titanium dioxide material," said Koodali. "This way we not only have an effective photocatalyst but we also have a material that can absorb visible light."

The photocatalyst developed is able to use visible light from the sun to produce hydrogen and oxygen without the addition of other chemicals. This is achieved using special materials, which have pores 1,000 times smaller than a human hair, to help facilitate the chemical reaction.

"What is interesting is the pores facilitate the fast diffusion of water molecules into the active titanium dioxide and quantum dot sites," said Koodali.

Koodali and Peng added there is only a small group of researchers studying photocatalytic water splitting using mesoporous-based materials.

"Our research is really unique," said Peng. "We have our own novelties in this research because this is the first report that can use visible light for catalytic water splitting to generate both hydrogen and oxygen."

The hydrogen and oxygen gas produced by the experiment is analyzed every hour, Peng added. The whole experiment has been prolonged up to eighteen hours to investigate the stability of the catalyst.

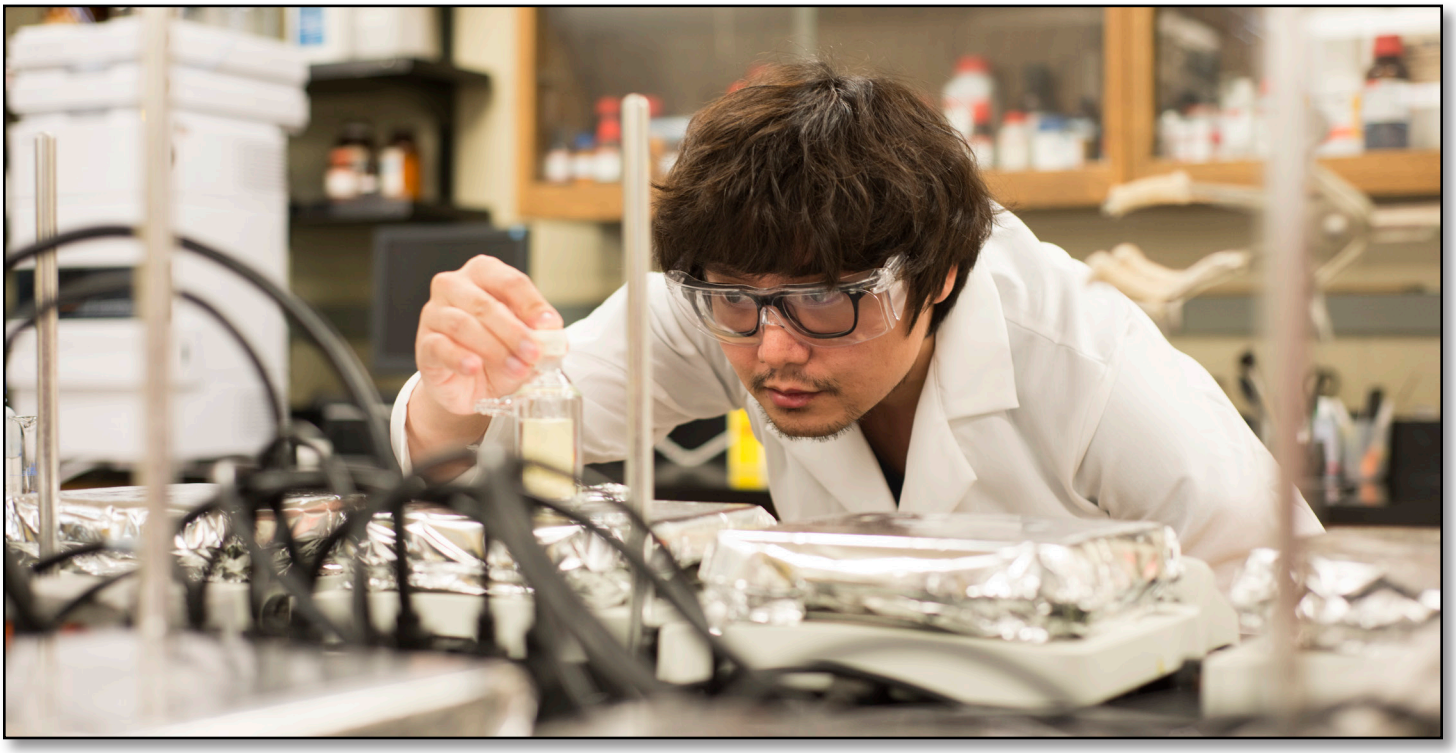
Although the research at USD has produced new achievements in harnessing solar energy, there is still progress to be made.

A light designed to mimic natural sunlight shines light on the photocatalyst solution as part of the experiment.

Currently, the team at USD has a photocatalyst that is very stable in experimental conditions and can be used repeatedly, says Peng.

Peng is improving the catalyst to be as stable and efficient as possible while producing larger volumes of hydrogen and oxygen. Other students at USD are studying other applications of the photocatalysts including degrading water pollutants from household and industrial products.

"The most fabulous part of research is you never know where it will lead you," said Peng.



Rui Peng prepares a sample of water mixed with a photocatalyst that can split water into hydrogen and oxygen using only visible light.

Invisible ink could stop counterfeiting

This article is reprinted with permission from the Argus Leader.

Invisible code technology developed in South Dakota could prevent the counterfeit and forgery of a variety of products from medical devices to golf balls.

Professors Stanley May from the University of South Dakota and William Cross and Jon Kellar of the South Dakota School of Mines and Technology have developed an invisible ink using nanoparticles. The ink is unable to be seen until revealed with a near infrared laser.

In their article published in the British journal Nanotechnology, the professors used the ink and printing technology to create invisible quick response, or QR codes. The barcode-like squares can be read by smartphones and often are used for consumer marketing.

But rather than marketing, the new technology has a wide range of security applications that could help curb counterfeiting of products and brands.

"The spectrum is document security to actual product security and protection of intellectual property," Kellar said.

The technology can be adapted chemically to be compatible with almost any surface, May said.

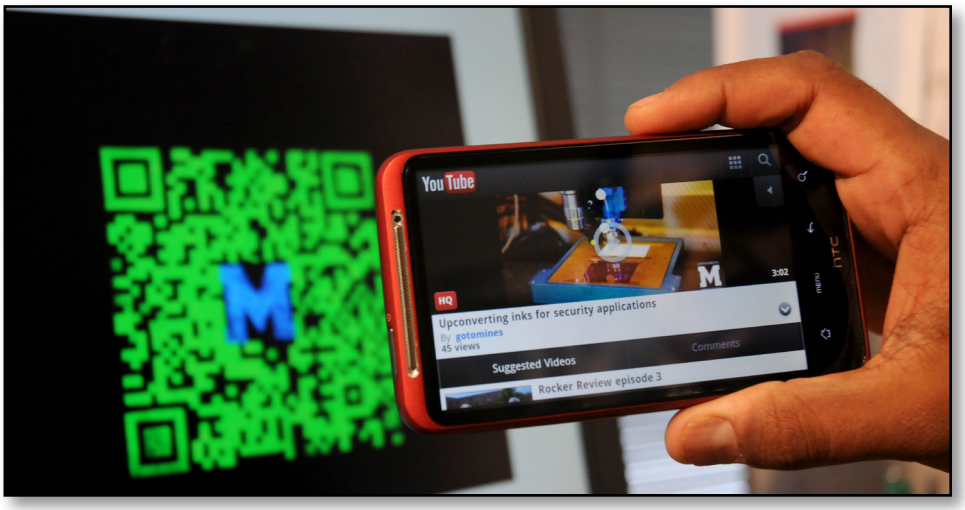


Photo courtesy of South Dakota School of Mines & Technology University Relations.

"We can print them on paper, glass, metal – almost anything," he said.

Many people might be surprised to learn the sort of items that are being counterfeited, May said.

"It's just hair-raising, really. The things that are counterfeited and just sort of substituted into the supply chains are just pretty amazing," he said. "It's not just money and notes or Rolex watches and stuff but down to things like cereal and things like that. You may not believe this, but golf balls are a big thing."

The international Organization for Economic Cooperation estimates that forgery and counterfeiting costs businesses, governments and taxpayers $250 billion per year. As recently as the so-called Cyber Monday on Nov. 29, the U.S. Department of Justice and U.S. Immigration and Customs Enforcement shut down 82 websites selling counterfeit goods.

"The sale of counterfeit U.S. brands on the Internet steals the creative work of others, costs our economy jobs and revenue, and can threaten the health and safety of American consumers," ICE director John Morton said in a news release.

The special ink developed in South Dakota can be used to print any type of code, so if applied commercially, simple QR codes that could be scanned by smartphones likely wouldn't be used.

"If you're going to really secure something, you'd develop your own code that is encrypted," Kellar said. "It all depends on the critical nature of what you're trying to protect. As it becomes more critical, you will put more technology into protecting it."

Their continued research is focused on advancing and adapting the technology for more secure specific needs.

"We're talking to a number of people now about what their application is and how this might be adapted to what their interests are," May said.

The researchers are trying to cover a large range of security technologies, Cross said.

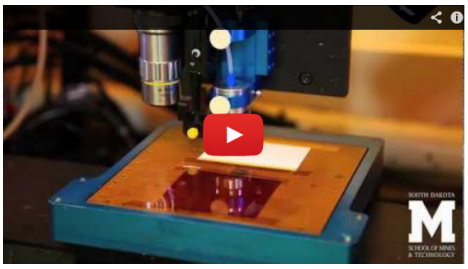
"We're trying to work on things from the printing aspects – how you read what you print – all the way up to database security and things like that," he said.

Their research has garnered international attention. Media outlets such as the BBC, Reuters and NBC News have picked up the story.

The professors attribute the appeal to their pairing of familiar technology alongside clandestine technology.

"The fact that we used a smartphone to read the covert code, I think that piqued the public interest," Kellar said. "Then there's the whole 'CSI: Miami' factor. People are intrigued by covert technologies and things like that."

Watch the Video



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BHSU chemistry faculty and students work to improve solar energy efficiency

This article is reprinted with the permission from BHSU University Relations

Dr. Katrina Jensen, Black Hills State University assistant professor of chemistry, and two undergraduate chemistry students, are working on a research project that could lead to the development of less expensive solar cells.

The BHSU professor and two students Samantha Petit, chemistry and environmental physical science major from Belle Fourche, and Dylan Dobbs, chemistry major from Hot Springs, are currently working on a project looking at options on the molecular level that might increase efficiency of solar cells.

For nearly two centuries, scientists from all over the world have researched the most efficient way to convert light into electricity.

Major strides have been made from the first photovoltaic effect experiment to the solar panels now used on homes around the world. However, solar cells used in the solar panels are currently made with highly refined crystalline silicon, which remains expensive. The cost keeps many people from using this type of renewable energy, Jensen said.

Advanced solar energy technology that uses materials other than silicon could significantly reduce the cost of solar energy.

"We are looking at using chemistry to make new dyes and testing their efficiency and see how they work," Jensen said.

The dye-sensitized solar cells, which are named for the colored molecules that enable them to absorb sunlight, being studied by Jensen, along with her students, are potentially less expensive to make than other types of cells but still lack the efficiency of silicon.

"Our goal is to study (the cells) on a molecular level to increase efficiency," Jensen said. The development of highly efficient materials that cost less than current technology could potentially lead to future production of new, better solar devices, she said. Their work is still in the early stages.

"We are still working on the chemistry part of it – building new dye molecules," she said. "We hope to be able to build dyes, test them and then design something that's even better."

Dr. Katrina Jensen, BHSU assistant professor of chemistry, and undergraduate students Samantha Petit and Dylan Dobbs are working on a research project that could lead to the development of less expensive solar cells.

Jensen's research is supported by the SD EPSCoR Research Infrastructure Improvement grant. The program promotes the development of science and technology research in smaller states giving them a more competitive edge on a national level. This project is one of many underway at BHSU which gives students the opportunity to participate in faculty mentored research on issues that have national and international impact.

BHSU recently received nearly $300,000 from the Board of Regents for laboratory equipment to support the University's growing research programs in biomedical research and renewable energy. Some of these funds were used to purchase an instrument to test the efficiency of new solar energy devices.

"It's great," Jensen said of the new equipment. "We can do everything here. We can build and test the materials."

The development of dye-sensitized solar cells can provide a cheaper alternative to the expensive refined crystalline silicone used in current solar cells.

RII Track 2 grant awarded to South Dakota and North Dakota to establish the Dakota Bioprocessing Consortium

A $6 million Research Infrastructure Improvement (RII) Track 2 grant has been awarded to the South Dakota and North Dakota Experimental Program to Stimulate Competitive Research (SD & ND EPSCoR).

The RII Track 2 award is funded by the National Science Foundation (NSF) and will be four universities from the two states to establish the Dakota Bioprocessing Consortium (DakotaBioCon).

DakotaBioCon's goal is to create a collaborative infrastructure to enable and facilitate the development of novel bioprocessing technologies for sustainable production of high-value chemicals and materials from renewable resources, such as switchgrass, forest waste material from lumbering, and municipal waste.

Researchers at the universities will work to develop sustainable resources based on biomass processing. Bioprocessing of renewable resources addresses strategic national security priorities by reducing national dependence on imported oil and creating new jobs.

"This project builds on research infrastructure investments that both the South Dakota and North Dakota EPSCoR programs have been making for the last five years in the basic and applied sciences," said SD EPSCoR Director James Rice. "Without these investments this proposal couldn't have been funded."

Universities participating in DakotaBioCon are:

- South Dakota State University
- South Dakota School of Mines and Technology
- North Dakota State University
- University of North Dakota

SD EPSCoR awards $200,000 to SD school districts to strengthen STEM Education

South Dakota school districts have received $200,000 through SD EPSCoR awards this year to fund projects in Science, Technology, Engineering and Mathematics (STEM).

The goal of projects funded by the awards is to increase career opportunities and achievement of middle and high school students by enhancing, expanding and developing new programs and opportunities in specific career clusters.

"South Dakota schools need this funding in order to provide high quality, rigorous programs," said Ray Tracy, an education program specialist with the South Dakota Department of Education. "Many districts offer the core courses to students and they need additional support to introduce specialized programs."

Tracy says when schools implement rigorous programs there are some key expenditures. Funding from SD EPSCoR is essential because school districts do not ordinarily have the initial startup funds to begin STEM programs.

"First, professional development for teachers is essential to increase the knowledge of the teacher and to promote best teaching practices," said Tracy. "Secondly, a school district may need to upgrade or acquire equipment, curriculum, or other instructional materials (such as software) that will assist in the classroom or activity."

Brookings High School Teacher Jane Syltie is one of the applicants who received an award from SD EPSCoR. She used the funds to host a Gateway Camp for middle school students in Brookings, S.D.

Gateway Camps are five-day-long programs to enhance middle school students' interest in science and engineering. Students are engaged in activities such as robotics and making stomp rockets.

Syltie said the Gateway Academy Camps would not have happened without funding from SD EPSCoR. She was encouraged to start the camp in Brookings three years ago.

Riley Nupen and Parks Brawand work on a robot during a 2013 summer camp in Brookings, S.D. Courtesy photo

"Right away I could see the value," said Syltie.

The camp gives the students the opportunity to learn about science and engineering, which, according to Syltie, are subject areas middle school students have not had an opportunity to learn much about yet.

"The primary benefit for enhancing middle and high school STEM programs is providing experiences for students," said Tracy. "Students who are interested in STEM experience engineering, mathematical, scientific, and technological activities are able to develop their interests and potential future career in the STEM fields."

SD EPSCoR funded 14 projects in South Dakota in 2013, said Tracy. Currently 10 projects are to be funded for 2014 and potentially two more.

Internship program benefits SD students and businesses through economic development

The Dakota Seeds Internship Program is a partnership between SD EPSCoR and the SD Governor's Office of Economic Development (GOED).

Since its inception in April 2008, Dakota Seeds has helped to create more than 660 internships in STEM disciplines and has involved more than 180 companies.

The programs goals are to facilitate the needs of both students looking for internships and businesses looking for internship funding.

Ann Gesick, GOED training coordinator, said what these students didn't realize was the number of companies in the state who work with ethanol, research programs, engineering and information technology jobs.

"We wanted these students to have the chance to see what kind of opportunities are here in South Dakota for them while they are interns and can transition in to a long-term career," said Gesick.

Andres Abraham, a junior at South Dakota State University, spent his summer as an intern at the Rainbow Play Factory in Brookings. He said the experience was beneficial because it was his first time in a professional office setting.

"I can say it's been a pretty nice experience and it makes me think I made the right decision when deciding to start mechanical engineering," said Abraham. "It made me grow a lot as a professional and makes me feel motivated to keep going on with school."

Hiring student interns like Abraham can be difficult for some companies, many of which are newer startup companies who do not yet have the resources to hire interns without support. Dakota Seeds, using fund provided through SD EPSCoR, steps in and shares those costs with the companies.

SDSU undergraduate student Andres Abraham examains a test sample during his Dakota Seeds sponsered internship with the Rainbow Play Factory in Brookings S.D. this summer.

"The company pays the student and then at the end of the internship, they submit an invoice for up to the amount of money we had committed for the reimbursement," said Mel Ustad, the Director of Commercialization at the SD GOED. "The minimum is 1-1 for matching."

With this system in place, start-up companies that may not be able to afford an intern can now have the resources to offer internships. This process in turn helps the business to find full-time employees as their company grows.

"The purpose is to increase the use of internships to develop future workers and also help to utilize young interns to support young early-stage companies," said Ustad.

Both Ustad and Gesick agreed the best outcome is the number of interns who are offered full-time positions after the internship period comes to a close.

"The biggest impact is the number of interns that then become full-time employees," said Ustad. "Typically that's about 30-40 percent."

According to Gesick, internships can lead to full-time jobs because the business can learn first-hand the work ethic each student has.

"It really gives companies a chance to test drive the students, if you will, to see if they will be a good fit for their company," said Gesick.

Abraham said that while his internship was scheduled to end soon, he was asked to continue on at part-time status when school begins.

While the direct impact is on the students and the companies, the program is also impacting the curriculum at universities and colleges in the state.

"It helps to foster a relationship between the universities and business community," said Ustad.

Working with businesses influences the curriculum taught in universities by understanding what skills employers are looking for in future employees. It also generates collaboration between student research and companies.

The influence of Dakota Seeds is continuing to grow and is a beneficial learning experience for the companies, the students, schooling, and the South Dakota community.

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