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USF: Clean Air Technologies

USF graduate students Patrick Nugent and Stephen Burd are part of the international research team to discover a metal-organic material that does a more efficient job at capturing carbon. Photo Credit: Aimee Blodgett

Chemists at the University of South Florida and King Abdullah University of Science and Technology have discovered a more efficient, less expensive and reusable material for carbon dioxide (CO_2) capture and separation.

The breakthrough could have implications for a new generation of clean-air technologies and offers new tools for confronting the world's challenges in controlling carbon.

Publishing this month in the prestigious journal Nature, the international group of scientists has identified a previously underused material – known as SIFSIX-1-Cu - that offers a highly efficient mechanism for capturing CO_2.

The discovery represents more than an improvement over existing materials in terms of carbon capture, said USF Chemistry Professor Mike Zaworotko, noting that the material also is highly-effective at carbon capture even in the presence of water

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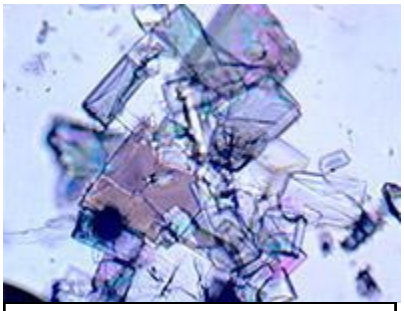
vapor, a standard that other materials have not been able to meet. This makes it a promising candidate for real-world applications. Water normally interferes with CO_2 capture, but the material developed in the USF-KAUST project resists it.

"I hate to use the word 'unprecedented' but we have something unprecedented," Zaworotko said. "We sort of hit a sweet spot in terms of properties."

The discovery addresses one the biggest challenges of capturing CO_2 before it enters the atmosphere: energy costs associated with the separation and purification of industrial commodities currently consumes around 15 percent of global energy production. The demand for such commodities is projected to triple by 2050, the researchers note.

The problem is pronounced in capturing CO_2, which in addition to its notoriety with climate change, is an impurity in natural gas, biogas and other gas streams, they said.

The material is a crystal whose atoms form a three-dimensional lattice with holes that snare molecules of CO_2 but allow other molecules in air to pass. SIFSIX-1-Cu is an adaptation of a material created more than 15 years ago and is named after the chemical component that leads to the special properties; its chemical name is hexafluorosilicate.



The metal-organic framework material at the center of a new discovery by chemists at the USF and KAUST is shown under a microscope. The crystals have been found to be a more efficient, less expensive and reusable material for carbon capture and separation, and is a promising breakthrough in developing better carbon-control technologies. Photo Credit: USF/Mike Zawortko

Porous SIFSIX materials are built from combinations of inorganic and organic chemical building blocks and are part of a general class of materials known as Metal-Organic Materials, or "MOMs".

The breakthrough is several years in the making and began with an undergraduate research project conducted by USF student Stephen Burd under Zaworotko's supervision. Now a graduate student in chemistry, Burd's initial testing of the material and discovery of its high-selectivity for CO_2 then grew to involve an international research group involving USF chemists Brian Space, Shengqian Ma, Mohamed Eddaoudi (who is also a faculty member at KAUST) and graduate collaborator Patrick Nugent.

The research facilities at KAUST in Saudi Arabia combined with the multidisciplinary expertise in Eddaoudi's research group – which includes researchers Youssef Belmabkhout, Amy Cairns and Ryan Luebke - allowed the design of unique experiments that permitted the sorption (the physical and chemical process by which substances attach to each other) properties of this class of materials to be unveiled.

To confirm their findings, the researchers used supercomputer simulations in the National Science Foundation's XSEDE network.

"We work with the experimental groups in a back-and-forth process," Space said. "We tried to explain their data, and our results give them hints on how to change the way the material works."

Space's team used several supercomputers in the National Science Foundation's XSEDE network for this work. They initially used Pittsburgh Supercomputing Center's Blacklight to simulate the behavior of small numbers of gas molecules with each other and with the MOM material.

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Predicting the exact behavior of even small numbers of molecules requires a huge amount of computer memory — more than one terabyte, greater than the RAM memory in a thousand brand-new iPads. Such calculations are a specialty of Blacklight, the largest "shared memory" computer in the world. The researchers then used the Blacklight results to simulate the behavior of the gasses and the MOMs in bulk on XSEDE computers Ranger, at the Texas Advanced Computing Center, and Trestles, at the San Diego Supercomputer Center.

The group believes the material has three potentially significant applications: carbon-capture for coal-burning energy plants; purification of methane in natural gas wells; and the advancement of clean-coal technology. Some 20 to 30 percent of the power output at a clean-coal plant is consumed by cleaning process. The new material could make those plants more efficient and put more power into the grid, the scientists predict.

The next step is to collaborate with engineers to determine how the materials can be manufactured and implemented for real-world uses.

To read the full publication, **"Porous materials with optimal adsorption thermodynamics and kinetics for CO2 separations"** visit the journal Nature **here.**

FAU Researchers to Study Carbon Dynamics of the greater Everglades and Implications of Climate Change

BOCA RATON, Fla. (March 11, 2013) – Florida Atlantic University researchers Brian Benscoter, Ph.D., and Xavier Comas, Ph.D., have been awarded $570,000 from the U.S. Department of Energy to serve as collaborators for research related to carbon cycling and climate change in Florida's Greater Everglades.

Benscoter, assistant professor in the department of biological sciences at FAU's Davie campus, will examine how plant communities respond to their environment, particularly changes in temperature and water availability, to help evaluate regional carbon cycling in the Greater Everglades in a changing climate.

"The Greater Everglades, like many subtropical and tropical wetland watersheds globally, are of vital importance in terms of both their intrinsic ecological importance as well as their services that support neighboring, dense human populations," said Benscoter. "The carbon-rich soils of the Everglades have the potential to significantly influence the global climate, so understanding how the ecosystem may respond to changes in environmental conditions is of great importance."

Comas, an assistant professor in the department of geosciences at FAU, will use surface geophysical methods, including ground penetrating radar, to investigate patterns of accumulation and release of methane and carbon dioxide in soils and estimate the below-ground soil carbon storage in the Greater Everglades watershed.

"With these measurements we hope to achieve a better understanding of carbon availability at different scales of measurement and biogenic gas dynamics and gas flux patterns in different environments across the Greater Everglades Watershed," said Comas. "The project will help us to better define the balance between carbon accumulation and losses in the Greater Everglades, and how disturbances such as climate change may potentially impact such a balance."

UCF to Receive $1.4 Million Grant to Open Entrepreneurial Center

The University of Central Florida will open an entrepreneurial center in the Student Union this summer.

But unlike similar programs that cater largely to business students and others in specific majors, this one will invite all students — from freshmen to doctoral candidates, art majors to future physicists — to come in for advice about how to develop plans for new products and services.

The goal, organizers said, is to help students realize they don't have to go to work for someone else after they graduate. With some free guidance from experts and mentors, they can start their own businesses, which university officials hope will, in turn, spur economic growth and job creation

On Monday morning, university and community leaders will gather at UCF to announce the creation of the Blackstone LaunchPad, named after the global investment and advisory company spearheading the project.

It's modeled after an entrepreneurial program at the University of Miami that has drawn almost 2,000 students and helped create 85 companies since 2008. The Blackstone Charitable Foundation, the investment company's nonprofit arm, is replicating that initiative at other colleges and universities.

UCF will be the 10th location, and the second in Florida. It was chosen because of its size — it's Florida's largest public university — and because of the entrepreneurial programs already in place at the school.

"If you're really thinking about doing something entrepreneurial, we can provide a spark for that," said Stephen A. Schwarzman, the co-founder and chief executive officer of Blackstone, which has investments in several companies that operate in Central Florida, including Sea World, Michaels Stores and Hilton Worldwide.

"We can provide advice," Schwarzman said, "and we can increase your prospects for success."

Blackstone's foundation is giving UCF a $1.4 million grant to develop and staff the center. The University of Miami will provide training and technical assistance.

UCF students will be able to meet with consultants at the LaunchPad to get feedback about their ideas. They also will learn such skills as how to assess markets, prepare financial statements and write business plans, said Cameron Ford, who is director of the UCF Center for Entrepreneurship & Innovation and is helping develop the UCF LaunchPad. "Different students have different strengths and different blind spots, so we will be listening to them and assessing what their needs are and helping guide them through the challenges they might face," Ford said. "We're teaching them to be entrepreneurial thinkers and leaders."

Students whose ideas have the most promise will be paired with coaches and mentors who work in the Central Florida area and have industry-specific expertise.

Blackstone estimates that the UCF LaunchPad could generate about 300 new companies and more than 780 jobs after five years.

UF Researchers Improve Process to Create Renewable Chemical from Plants

GAINESVILLE, FL - Crops aren't just for food, fiber and fuel. Researchers at the University of Florida are making new industrial applications possible for them as well.

They've developed a method to turn sugarcane bagasse — the crushed-stalk waste product of sugar production — into succinic acid that can be used to make pharmaceuticals, protective coatings and compostable bags.

The process uses no food crops or petroleum as raw materials. In contrast, most currently produced succinic acid is petroleum derived. The research is detailed in a study in the March 5 issue of the journal Proceedings of the National Academy of Sciences.

"I believe renewable chemicals will be at least a part of the future of our chemical industry, if we want to decrease the demand for petroleum," said Xuan Wang, the study's lead author and an assistant scientist in UF's microbiology and cell science department.

Renewable chemicals are created from materials that can be replenished, whereas nonrenewable chemicals are produced from limited resources, such as petroleum.

The research is part of a larger project led by Lonnie Ingram, a distinguished professor in the department and a member of UF's Institute of Food and Agricultural Sciences. His work seeks to turn discarded plant material, as well as sugars produced from crops such as sweet sorghum, into fuel and renewable products in a cost-effective and economically viable manner.

Key to the research are E. coli bacteria that Ingram and his team have genetically engineered to produce specific products by fermenting sugar. The team's previous accomplishments include E. coli strains that can produce fuel ethanol and ones that make lactic acid, which is used to create biodegradable and recyclable bioplastics.

To achieve cost-effective succinic acid production using waste plant materials, however, the researchers had to make an E. coli strain tolerant to growth-stopping inhibitors. The newly engineered strain, called XW 136, produced more than 30 grams per liter of succinate using sugars derived from sugarcane bagasse.

This was the first time succinic acid production from sugarcane bagasse had been achieved without the use of expensive and cost-prohibitive steps to remove the inhibitors, Wang said.

"The inhibitors produced from waste plant materials are barriers for the industrial chemical production using renewable sources," Wang said. "Now our work provides a direction for effectively improving inhibitor tolerance."

The ethanol production technology from Ingram's research team, including the genetically engineered bacteria, is currently in use in fuel plants in Florida, Louisiana and Japan. Microorganisms the team has engineered to make bioplastics are being used in facilities in Louisiana and Spain.

FIU Leads National Study on South Florida's Water Supply

A team of researchers led by FIU has been awarded a $5million grant from the National Science Foundation to conduct a five-year study of South Florida's water supply.

The study is part of the National Science Foundation's Water, Sustainability and Climate program dedicated to enhancing the understanding of andpredicting the interactions between the water system and land use changes, the built environment, ecosystem function and services and climate change/variability through place-based research and integrative models.

Every day in South Florida about 7.7 million people, companies and farms, use more than **3 billion gallons** of water. And with the expected growth in South Florida population, it is necessary to find different ways to optimize water use in the area.

"This research will help south Florida to understand the economic and ecological values of its water resources, and use this information to shed light on the trade-offs that decision makers will be faced with in the next century," said project leader Mike Sukop, associate professor in the Department of Earth and Environment in FIU's College of Arts & Sciences. "It's important that we begin this work now because sea level rise may start to have dramatic effects on South Florida in the coming decades, and water managers are likely to be challenged both by flooding and water supply problems."

This study continues the university's leadership as one of the top water research universities in the country, with funded projects in water issues ranging from water supply, sanitation, and wetland ecosystems to water resources management and public policy. Under this grant, FIU will coordinate the efforts of scholars and scientists from the University of Miami, University of South Florida, University of Florida, Florida State University, University of Central Florida, University of Hawaii, Michigan Technological University, Pennsylvania State University, and University of Pennsylvania, along with researchers from Geodesign Technologies.

U.S. Department of Defense Recommends FAMU for $1.9 Million Grant

TALLAHASSEE, Fla. (March 27, 2013) – Florida A&M University (FAMU) has received notification from the U.S. Department of Defense (DOD) for recommended grant funding totaling more than $1.9 million to support research at the university for the next three years. The U.S. DOD Research and Education Program for Historically Black Colleges and Universities/Minority-Serving Institutions (HBCU/MI) provides support through the DOD's U.S. Army Research, Development and Engineering Command Army Research Office.

The recommended grant awards will support the following research projects of faculty at the FAMU-Florida State University (FAMU-FSU) College of Engineering:

- High Temperature Supersonic Jet Noise-Fundamental Studies and

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Control using Advanced Actuation Methods (Farrukh Alvi);

- A Novel Approach to Adaptive Flow Separation Control (Emmanuel Collins);
- Towards Ultra-light Weight Hybrids, Foams and Green Bodies: Structure-Property Relationships in Novel Polymer Grafted Nanoparticles (Subramanian Ramakrishnan); and
- Simulation of Fluid-Structure Interaction for High-Reynolds-Number Compressible Flow (Kunihiko Taira).

The recommended funding will allow these principal investigators to conduct research in aeroacoustic prediction capabilities and actuator placement design in future work. They will explore the architectures of materials that give rise to enhanced toughness (durability) while simultaneously being amenable to processing and maintaining their properties over longer periods of time with current technologies. These findings may lead to better protection for U.S. troops.

"FAMU is extremely excited about these research initiatives and the faculty's dedication in conducting research and training the next generation of engineers," said K. Ken Redda, professor and interim vice president for Research. "I appreciate the hard work and dedication of these principal investigators in attracting these competitive grants that help support U.S. military initiatives. We are elated to have been recommended by the DOD's Army to conduct new and innovative research."

The Research and Education Program for HBCU/MI enhances research programs and capabilities in scientific and engineering disciplines critical to the national security functions of the DOD; it encourages greater participation by HBCU/MIs in DOD research and education programs and activities; increases the number of graduates, including underrepresented minorities, in the fields of science, technology, engineering and mathematics (STEM); and encourages research and educational collaboration with other institutions of higher education.

USF: Water Issues on Tap

Nancy Stoner, the EPA's acting assistant administrator for water, visited three labs during her visit to USF Wednesday. Photo: Aimee Blodgett | USF

TAMPA, Fla. (March 27, 2013) - The Environmental Protection Agency's chief water administrator unveiled Wednesday a new "blueprint" for innovation to address the nation's issues in water cleanliness and safety as she toured a trio of University of South Florida laboratories where new technology is addressing age-old issues.

The EPA's blueprint calls for greater national support for emerging technologies in water treatment, testing and reuse, as well as an easing of barriers to greater collaboration and innovation among academic, industry and government researchers.

Nancy Stoner, the U.S. Environmental Protection Agency's acting assistant administrator for water, and officials from the Water Environment Federation made the announcement in a visit to USF's Patel College of Global Sustainability and three university laboratories where technologies

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are being developed to detect waterborne pathogens, convert wastewater into renewable resources and grow algae for bio-fuel production.

"What we are trying to do is encourage the development of technology that solves real-world problems, that's what is being done here," Stoner said immediately after learning about new technology developed by USF Professor Daniel Lim and his research team that can more easily detect pathogens such as E. coli in water at contaminated beaches or in fruit and vegetable processing.

The inexpensive, portable testing equipment developed by the lab is patent-pending.

"There are all kinds of exciting things being done in laboratories; it's time to scale them up," Stoner added.

Stoner was hosted by Patel College Dean Kala Vairavamoorthy and joined by Jeff Lape, deputy director of EPA's Office of Science and Technology; Jeff Eger, executive director of the Water Environment Federation; and Matt Ries, chief technical officer for the Water Environment

Federation and senior research fellow at USF's Patel College of Global Sustainability and a doctoral student in civil engineering at USF.

The new EPA blueprint put the focus on technological innovation in drinking water system, wastewater treatment and management, water reuse and reducing the amount of water used in domestic energy production. Sustainable water issues are a major research focus for USF throughout the university, but particularly in the newly-created Patel College.

"In the future we won't be building water treatment and wastewater treatment plants, we will be building water machines, machines that produce water, energy, nutrients, etc," Vairavamoorthy told Stoner.

"There is a need for a comprehensive management of urban water systems by adopting more intelligent treatment technologies, including water recycling, and IT for monitoring and control of urban water systems. The convergence of these technologies offers great opportunities to the water sector."

The delegation's visit took them to the laboratory of Daniel Yeh, an associate professor of Civil and Environmental Engineering, who has developed new technology that converts wastewater into clean water, nutrients and energy. Yeh's project, partially funded by a 2011 grant from the Gates Foundation, has drawn worldwide interest because of its potential to turn wastewater into a renewable resource.

In Lim's Advanced Biosensors Laboratory, the delegation was able to see his invention – the Portable Multi-Use Automated Concentration System – is able to quickly and easily detect waterborne diseases. The machine is able to concentrate low levels of microbial pathogens in large volumes of water, making it useful for detecting contamination at beaches, in rivers and even in fruit and vegetable processing plants.

"Those of us who live in the Tampa Bay area know how often the beaches are closed for two or three days to test for pathogens in the water," he said. "We can do that in two or three hours."

The device has been tested extensively in various scenarios, but isn't on the market because it is still considered research equipment and not having met regulatory standards and asked Stoner for the EPA's assistance in easing the path from new innovation to usable technology.

The group also traveled to Lakeland to visit a biofuels laboratory created by George Philippidis, a USF associate professor in the Department of Chemical and Biomedical

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Engineering. As director of the Renewable Fuels Laboratory, Philippidis has engineered technologies to grow fuel-producing algae while reducing water and energy consumption.

To read the EPA Blueprint for Integrating Technology Innovation into the National Water Program click **here**.

Recent Funding Opportunities

FESC office tracks the energy related funding opportunities, shares them with faculty and industry partners, facilitates the submission of multi-faculty, multi-SUS university competitive proposals in response to solicitations for major research programs. The most recent funding opportunities are listed below. For a complete list please visit the funding opportunities page on the FESC website.

- **DE-FOA-0000894: FY2013 Unconventional Gas and Oil Technologies**
  Application due date: June 17th, 2013
  More Information

- **DE-FOA-0000895: Uncertainty Quantification Methodologies for Enabling Extreme-Scale Science**
  Application due date: May 24th, 2013
  More Information

- **DE-FOA-0000800: Cost-Shared Development of Innovative Small Modular Reactor Designs**
  Submission Deadline: July 1st, 2013
  More Information

- **DE-FOA-0000785-Bench– and Pilot– Scale Applications for R&D of Post Combustion and Pre-Combustion CO2 Capture Technologies for Coal-Fired Power Plants**
  Full Application: May 2nd, 2013
  More Information

- **NSF 13-545: United States-Israel Collaboration in Computer Science (USICCS)**
  Application Due Date: June 3rd, 2013
  More Information

- **DE-FOA-0000807: Nuclear Energy university Programs-Fellowship and Scholarship Support**
  Continuously Through: November 30th, 2015
  More Information