NETL-RUA
Regional University Alliance

NEWS

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A Golden Opportunity: NETL-RUA Researchers Turn Energy from Light into Thermal Energy

Photosynthesis, the process used by plants to convert light energy into chemical energy, may have been the inspiration for at least one National Energy Technology Laboratory – Regional University Alliance (NETL-RUA) team exploiting photoactive materials for carbon management. The team, whose work supports the NETL-RUA's Industrial Carbon Management Initiative, has synthesized a new catalyst that converts light energy into thermal energy to drive the catalytic conversion of carbon dioxide (CO_2) into methane and other useful chemicals.

The team's version relies on nanoparticles made of gold (Au) and zinc oxide (ZnO). "Small gold nanoparticles can generate a lot of heat when they absorb visible light," explained **Congjun Wang**, a URS scientist at NETL. The hot, optically active Au then heats ZnO nanoparticles, which use thermal energy to catalyze the conversion. "The heating is highly localized," Wang said, "so even when the temperature of the catalyst nanoparticles can reach several hundred degrees Celsius (°C), the reactor is still at room temperature. In other words, high-temperature catalysis reactions can now proceed at room temperature by simply shining light on our catalysts." The researchers have been able to use low-intensity visible light (blue light, for example) to heat the Au-ZnO catalysts up to 600 °C, with the product dictated by the intensity of the light.

The technology might have the Midas touch. The results were recently published in the journal *Nanoscale*[1], and the collaborative team, which includes researchers from West Virginia University (WVU), URS, and NETL, hopes someday to see the technology scaled up for large-scale deployment at power plants. Paired with solar energy or other light sources, it may greatly reduce fossil fuel greenhouse gas by-products—with the added benefit of also creating useful light gasses and industrial chemicals.

[1] Congjun Wang, Oshadha Ranasingha, Sittichai Natesakhawat, Paul R. Ohodnicki, Mark Andio, James P. Lewis, Christopher Matranga. "Visible light plasmonic heating of AU-ZnO for the catalytic reduction of CO_2." *Nanoscale*, Issue 15, 2013.

Happy Holidays!

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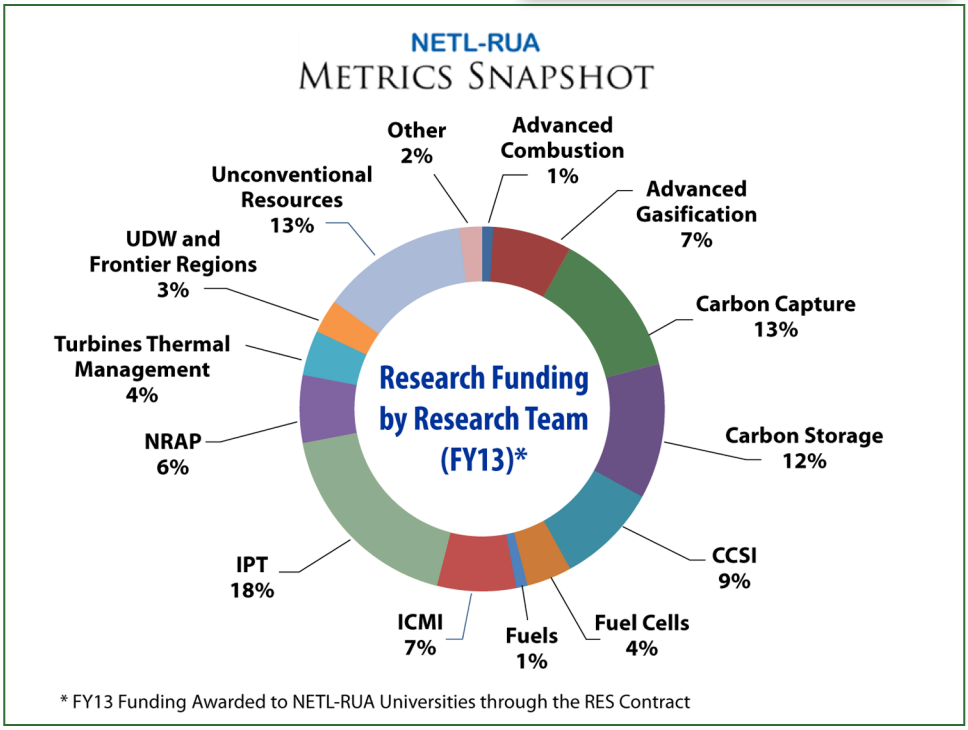
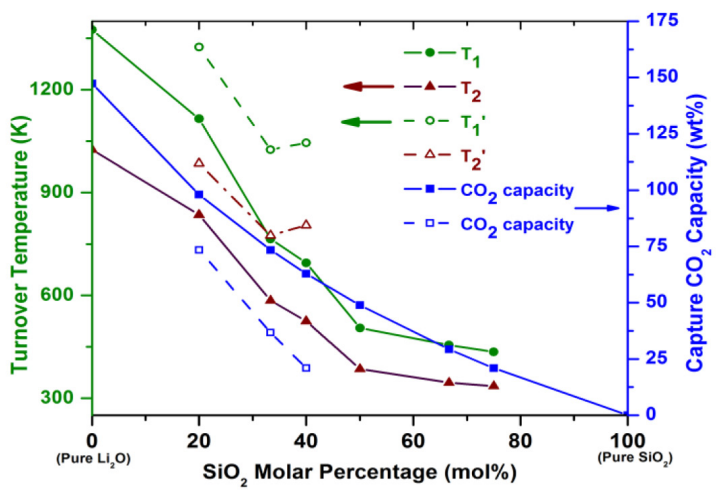


Stronger Together: Researchers from NETL and WVU Collaborate to Optimize Carbon Capture Sorbents

NETL research scientist **Yuhua Duan** collaborated with scientists from WVU to investigate how lithium oxide–silicon dioxide (Li_2O/SiO_2) and lithium oxide–zirconium dioxide (Li_2O/ZrO_2) solids can be tailored to efficiently capture CO_2 within a power plant's specific temperature range.

"In this research," says Duan, "NETL-RUA was involved in experimental tests and provided the theory on free energy minimization"—a principle underlying the study. "Such contributions made this research work more attractive and stronger," Duan adds. The project was a team effort. Researchers from NETL conducted computer modeling, and researchers from WVU helped analyze the modeling results and performed initial testing.



The researchers calculated the turnover temperatures and CO_2 capacities of a series of solids with different Li_2O/SiO_2 ratios. As this chart of their findings shows, solids that contain more Li_2O capture more CO_2 at higher temperatures.

The researchers' efforts paid off. They learned that a greater proportion of SiO_2 or ZrO_2 makes the mixed sorbent more suitable for capturing CO_2 at lower temperatures, with less energy cost. According to Duan, it's hard to find a single inexpensive material that can capture CO_2 in a power plant. "Our discoveries provide a way to synthesize [a] sorbent by mixing two or more materials," he says. "The mixed sorbent should possess better performance and kinetics than a single material."

The research team's findings go beyond Li_2O/SiO_2 and Li_2O/ZrO_2. "Based on this technology," says Duan, "we can mix different kinds of materials with low [economic] costs."

New Governance Structure for NETL-RUA

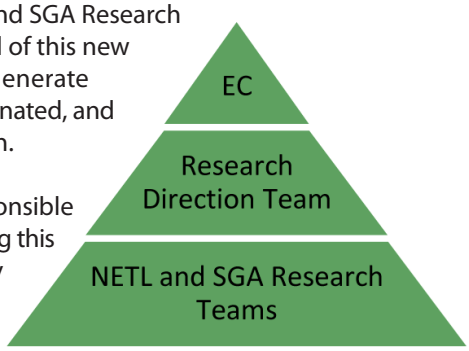
The NETL-RUA is implementing a governance approach that emphasizes both near-and long-term growth in its research and development (R&D) portfolio.

Near-term growth will be realized by tapping the power of NETL-RUA's 13 collaborative research teams to respond to external funding opportunities. Each research team will have a "Growth Champion" to lead the effort and assist with tracking both submissions and external funding awarded to his or her team.

The longer-term strategy focuses on winning large-scale opportunities that build R&D partnerships and expand the Alliance's research portfolio in areas related to NETL's core fossil energy work. These higher-value opportunities, though less frequent, are coordinated though three strategic growth areas (SGAs) currently sanctioned by the Executive Committee (EC): Grid Technology, Critical Materials, and Shale Gas.

Realizing NETL-RUA's Growth Missions

A new, three-tiered governance structure has been established consisting of the NETL-RUA EC, a newly created Research and Direction Team (RDT), and the existing NETL and SGA Research Teams. The goal of this new structure is to generate dynamic, coordinated, and targeted growth.



Growth Governance Structure

The RDT is responsible for implementing this growth strategy by establishing the strategic objectives, identifying new opportunities, developing partnerships, and making recommendations to the executive committee. This team comprises the university consortium area leads, the federal focus area leads, URS research directors, SGA and research team representatives, and—as their coordinator and spokesperson to the executive committee—a dedicated Growth Portfolio Manager.

The NETL-RUA and SGA research teams are responsible for executing the strategy. Each team is encouraged to seek opportunities for new sources of public and private funding and submit external proposals throughout the year. Clear roles and a cohesive strategy for growth make it easier to recognize and grow existing and potential NETL-RUA research and collaborations, and ultimately, sustain the mission of the Alliance.

Technology Spotlight

Going Small, Thinking Big: Nano- and Microgrids May Revolutionize Electricity Distribution

Electricity could one day provide 80 percent of power consumed nationally, but as of 2009, it accounted for just over 40 percent.[2] What's more, nuclear and renewable energy could occupy a greater portion of our energy landscape. For these changes to happen, the electric grid would have to double its capacity in the next two to three decades. Microgrids and nanogrids can hasten that expansion.

Microgrids and nanogrids can accommodate unconventional energy sources, such as solar panels and windmills, and deliver the energy they generate to the electric grid at large. *Source: Department of Energy,* Renewable Energy, *n.d., http://www.smartgrid.gov/the_smart_grid#renewable_energy, accessed December 2, 2013.*

A microgrid is a miniature electric grid. It can operate independently of, or in concert with, the existing grid. A nanogrid is similar but operates on an even smaller scale. Both nano- and microgrids can help stabilize the grid when, for instance, a storm damages power lines. They also "safely integrate energy sources, energy storage, and loads," says **Rolando Burgos**, an associate professor of electrical engineering at Virginia Polytechnic Institute and State University (Virginia Tech), an NETL-RUA member organization. So, solar panels on a house's roof, for instance, can transmit energy to the grid at large.

Nano- and microgrids "have only become a reality thanks to the development of high-power semiconductors," says Burgos. These semiconductors are integral to the power converters that allow nano- and microgrids to interact with the larger grid. Burgos is working with **Dushan Boroyevich** (Virginia Tech's American Electric Power Professor of Electrical Engineering) and other colleagues to investigate "the dynamic interactions, and, specifically, the stability problems generated by power converters connected to the grid," says Burgos.

Burgos credits the Grid Technologies Collaborative (GTC) for bolstering their research. The GTC was formed as an NETL-RUA SGA to advance research and development of the core technologies underlying advanced power electronics. Because GTC has been—as Burgos says—"fundamental in supporting the study . . . of grid-connected power converters," so too has NETL-RUA.

[2] Dushan Boroyevich (November 2013). "Intergrid: A Future Electronic Energy Network?" Presented at the 8th Annual Electric Power Industry Conference, Pittsburgh, Pennsylvania, Nov. 12, 2013.

Upcoming Event

- **NETL-RUA Spring Meeting**
  March 11, 2014
  Waterfront Place Hotel
  Morgantown, WV

Join Us Online

New Student Opportunity!

The Krell Institute has announced that applications are now being accepted for the Department of Energy (DOE) Computational Science Graduate Fellowship (CSGF). The CSGF program provides up to four years of financial support for students pursuing doctoral degrees in fields of study that utilize high- performance computing to solve problems in science and engineering.

The fellows are required to perform a 12-week practicum outside of their thesis topic at a participating DOE laboratory, with CSGF providing funding to cover extra expenses during this time. Because NETL is now a DOE Laboratory Practicum site, fellows may choose to spend their time at NETL working alongside one of the computational scientists at the lab. This is a great opportunity, and NETL-RUA students are encouraged to apply.

Applications are due on or before January 7, 2014.
Please visit http://www.krellinst.org/csgf/ for more information.

O'Connor and Lynch Join Penn State Faculty

Dr. Jacqueline O'Connor

Dr. Stephen Lynch

Drs. **Jacqueline O'Connor** and **Stephen Lynch** are the newest assistant professors of mechanical engineering at the Pennsylvania State University (Penn State), an NETL-RUA member organization. O'Connor heads up the Reacting Flow Dynamics Laboratory; Lynch directs the Experimental and Computational Convection Laboratory. Before starting at Penn State, the two met at the 2013 Turbo Expo, presented by the American Society of Mechanical Engineers. (O'Connor has dubbed the event her "favorite week of the year.") There, they realized their interests overlapped. She studies the combustors found in jet engines, and he studies the turbines downstream of them. Even though combustors and turbines occupy the "hot section" of an engine—so named because it reaches thousands of degrees Fahrenheit— many key questions remain that address the integration and coupling of these two components. As Lynch explains, that's "due to the complexity of each of those individual components." But optimizing jet engines, in terms of efficiency and environmental friendliness, will require researchers to look at the hot section as a unified system.

That's the approach Lynch and O'Connor are taking. They're working together to make better engine models and answer the lingering questions about what goes on in the hot section. "Flames are extraordinarily complicated," says O'Connor. "There are a lot of very detailed, very scientific issues that we still don't understand."

NETL-RUA is supporting research that will illuminate those issues. At Penn State's Steady Thermal Aero Research Turbine (START) facility, NETL-RUA researchers are, for example, investigating secondary flow rotating rigs. Lynch is already involved with the START facility, and according to **Karen Thole**, the head of Penn State's Mechanical and Nuclear Engineering Department, O'Connor will almost certainly get involved with NETL-RUA research as well. She notes that, by adding Lynch and O'Connor as assistant professors, Penn State is showing its commitment "to hire faculty who will likely collaborate with NETL in the future."

"I think this type of consortium adds a lot of value to the national lab system," O'Connor says of NETL-RUA. "Hopefully both Steve and I will bring different types of expertise to [it]."

NETL-RUA Student Researcher Wins the Robert T. Bruhn Award

Oshadha K. Ranasingha, a doctoral student studying Nanotechnology at West Virginia University, is a rising star. The results from his graduate work were recently published in the journal *Nanoscale* (see *A Golden Opportunity: NETL-RUA Researchers Turn Energy from Light into Thermal Energy)*, and at West Virginia's 5th biennial *Science, Technology and Research (STaR)* symposium. A video[3] he made describing that work won both the people's choice award and first place in the graduate student category.

Dr. Jan Taylor, Director of the WV Higher Education Policy Commission's Division of Science and Research, presents a check to Ranasingha at the WV STaR symposium.

To add to the accolades, Ranasingha was recently presented with this year's Robert T. Bruhn award. The award supports the research of a graduate or undergraduate student in Nanotechnology and Materials Science at WVU's Department of Physics and Astronomy. Ranasingha has been working in NETL labs to investigate local heating effects of zinc oxide due to the plasmon resonance of gold nanoparticles. He says the NETL-RUA has made it possible for him to use advanced equipment otherwise unavailable to him. To support his experimental results, he works on computational calculations in Dr. James Lewis' group at WVU.

Ranasingha completed his MS in Physics in May 2012 and expects to complete his PhD in Physics by spring 2014.

[3] Ranasingha's winning video can be viewed at: http://www.youtube.com/watch?v=vXRuLSTxOxk&feature=youtu.be

If you have information that you would like to feature in future newsletters, send that information to NETL-RUA-FB@netl.doe.gov. All issues of E News can be found on MOSS and the NETL-RUA website.

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