When Ingenuity Meets Industry

A cross-state research collaboration is making good progress on the commercial front

The research team, from left: Ph.D. candidates Lynal Albert and Hankai Zhu with their adviser, Derick Brown, associate professor.

Some 300 miles west of Bethlehem, Pa., Evoqua Water Technologies (formerly Siemens) in Warrendale, Pa., wants to build a better carbon product for battling bacteria.

The company, a supplier of municipal and industrial water and wastewater treatment equipment and services, has teamed up with Derick Brown, an associate professor of environmental engineering, his research group, and John Fox, an assistant professor of environmental engineering, to develop that product: An activated carbon with antimicrobial properties. The challenge is to make a carbon that can inhibit bacterial colonization and growth without leaching its own contaminants into water.

Evoqua has certainly come to the right lab. Interactions between bacteria and surfaces, and how they apply to environmental remediation and the treatment of waste streams, are a research specialty of Brown's, who is also a co-director of the Environmental Initiative at Lehigh University.

In 2001, Brown received a CAREER award from the National Science Foundation to pursue his interest in bacterial bioenergetics, a chemical process that determines how bacteria store and use energy. That energy is conserved in adenosine triphosphate (ATP), a compound capable of liberating large amounts of energy in the presence of the right enzymes. Brown thinks of ATP as the "money" in the cells of all living organisms—the currency that chemical reactions spend to produce energy in the body.

> ***The discovery of bioenergetics was so revolutionary that it won English scientist Peter Mitchell the Nobel Prize in Chemistry in 1978.***

Brown's research specifically focuses on bacteria and a physiochemical process called the charge regulation effect. It's based on the principle that cells have acid-based functional groups that give both positive and negative charges, depending on the pH of their environment.

Brown hypothesizes that ATP is affected by changes in pH at the cell surface. If bacteria approach a negatively charged surface, the pH drops and ATP rises. Conversely, on a positively charged surface, the pH rises and ATP declines—and if the cell doesn't make up for the loss in energy, it dies.

The charge regulation effect raised a new research question for Brown and his team: Could they modify the surface of activated carbon to make it more difficult for bacteria to colonize?

Hankai Zhu and Lynal Albert, who are both doctoral candidates advised by Brown, have been working to answer that question. First, they conducted lab experiments to test whether bacteria would grow on the activated carbon (it can). Now, they're applying their knowledge to new tests that replicate more closely what happens in the field.

"Eventually, we hope to show that it's possible to make a passive antimicrobial carbon—one that resists bacterial growth without requiring toxic chemicals that would impact the water we are trying to treat," says Brown. "That's information Evoqua can use to develop a commercial application for it."

The information is also potentially good news for matters of public health. Imagine coatings that make it harder for bacteria to colonize on water distribution pipes. Medical implants that work with the body's defenses to fight bacterial growth in the body.

Meanwhile, for all its promising progress, Brown's lab will soon have to forge ahead without the expertise of its newly-minted Ph.Ds. This fall, Albert joins the environmental engineering faculty of Tarleton State University. And Zhu will be graduating and is exploring opportunities in industry.

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