

CHEMICAL SOLUTIONS

Arkansas research is transforming health care and energy

Dr. Jingyi Chen, University of Arkansas

Dr. Jingyi Chen is a professor of chemistry and biochemistry at the University of Arkansas. But the Arkansas Research Alliance (ARA) Academy member may more accurately be described as an extraordinary solver of difficult problems. For example, as the world clamors for cleaner, cheaper and more reliable forms of energy, Dr. Chen and her team developed a process of generating electrical energy from ethanol – a fuel made by fermenting the sugar in the starches of grains, such as corn.

The challenge with extracting electric energy from ethanol is breaking the strong carbon-carbon bond that forms the ethanol molecule. Dr. Chen and her team developed a process called electro-oxidation that breaks the carbon bonds and releases more electrons – or electricity.

“What we hope to achieve is to make ethanol fuel cells a high-energy, high-density source of electrical power,” Dr. Chen explained. “These fuel cells can become lightweight power sources for electric cars and drones.”

While such technology is promising and could very well lead to an environmentally friendly and abundant source of energy, Dr. Chen’s work with nanomaterials has applications for a wide range of industries. Nanomaterials are materials of which a single unit is sized between 1 and 100 nm and are used in applications ranging from air purification to health care.

“I have two main directions going, both related to nanomaterials,” Dr. Chen revealed. “One direction involves catalysts for electricity-driven chemical reactions to produce cleaner energy. The second is to produce functional hybrid nanomaterials to fight against infections of bacteria and viruses, and to assist in the healing of hard-to-heal wounds, such as surgical wounds or the wounds one sees from soldiers on the battlefield.”

Nanomaterials can be used to stimulate cellular processes to activate wound healing. Dr. Chen is collaborating with ARA

Academy member Dr. Mark Smeltzer to develop nanomaterials that are antimicrobial, which would significantly reduce the chance for infection during the recovery of the wound. The technology is called Antimicrobial Photothermal Therapy (PTT), which involves the use of low-power lasers that operate at wavelengths that interact with the nanomaterials to control the release of antibiotics and kill microorganisms at low dose.

“Our team developed a composite material to combine an antibiotic-loaded silver/gold nanoparticle, which can enable a dual modal therapeutic approach, much more potent than each alone (antibiotic therapy or PTT),” Dr. Chen said.

“In doing so, we found something interesting. The release of the antibiotic is activated under illumination.

At the same time, silver/gold nanoparticles convert light to heat locally to destroy the bacterial cells. Together, the two components activate each other, leading to remarkable antimicrobial efficacy and the eradication biofilm infections.”

Successful development of this technology could help mitigate, or even eliminate, global antimicrobial resistance. Resistance to antibiotics is seen as a major issue by the Centers for Disease Control and World Health Organization. Arkansas sits at the forefront in this field of research, which could lead to a lucrative biotech niche built here in The Natural State. Dr. Chen’s next challenge is to bring this technology out of the lab and into the market.

From developing clean and abundant energy to creating life-saving nanotech therapies, Dr. Chen keeps busy in her lab at the University of Arkansas. And we’re all the better for it. 

