TECHNOLOGY MONITOR

Building at nanoscale, pushing the speed limit, meat substitutes and more

WARF Accelerator speeds the development of technologies with exceptional potential for commercial success. With targeted funding and expert advice from seasoned business mentors known as Catalysts, the program helps inventors develop their technologies and advance to the marketplace. The latest developments:

FOOD AND AGRICULTURE

COMPANION HEALTH:
Susannah Sample and Peter Muir from the School of Veterinary Medicine are leading a genomic sequencing project to understand why many Labrador retrievers develop a serious respiratory disease as they age.

Their team has completed sampling and isolation of DNA, and by the end of the year hopes to discover a mutation responsible for the disease. The next step would be the commercialization of a genetic test for at-risk canines.

NOT SO IMPOSSIBLE FOODS:
The market for plant-based burger and other meat substitutes is soaring. But just like meat, retaining an appetizing red/pink color is key to consumer demand. Mark Richards and Sofia Erazo (animal sciences) look to stabilize the color and lipid oxidation of meat substitutes containing plant hemoglobin with the goal of delaying browning during storage.

Erazo recently participated in D2P’s Innovation to Market course and is conducting interviews with target customers to refine the value proposition of their product.

CHARGED UP:
Mark Etzel (food science) and his group are on track to develop charged ultrafiltration membranes that improve the way food proteins – even infant formula – are manufactured. Since the project’s inception they have achieved a 1,500x scale-up from the lab bench to pilot plant and slashed processing time to under an hour.

Recently the team was invited to speak at a forum featuring key players in the sector. Prof. Etzel reports high interest and broad visibility for the technology.

HEALTH CARE

TARGET:
Work is underway to advance a potential new drug discovery platform that, remarkably, is inspired by the primordial origins of DNA. The method involves a ‘target-guided’ approach to synthesize peptides. Not only is this a fascinating research frontier, it could accelerate drug development by leapfrogging the screening activities currently necessary to identify therapeutic candidates.

John Yin (chemical & biological engineering) leads the project and plans to apply the method to a target with real human health relevance by the end of the year. If successful, the platform could be used to create peptides with the binding affinity and specificity of antibodies but at dramatically lower cost.

CLEAN TECH

DESALINATION BATTERY:
Kyoung-Shin Choi (chemistry) reports “significant progress” in her quest to develop a rechargeable desalination cell capable of turning seawater into fresh water. Her design uses bismuth as a chloride-storage electrode and, unlike other tech on the market, is membrane-free and consumes almost negligible electrical energy.

A member of Choi’s team recently attended the Tech Connect conference in Boston along with WARF staff, and was able to interact with potential commercial partners.

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Red Rover

A drone-mounted detector could help defeat the dark legacy of land mines. And become a game changer in global security.

From the jungles of East Asia to poppy fields in Colombia, death sleeps a few inches beneath the ground.

Across the globe an estimated 110 million land mines await reckoning. A fraction will be detected and dispatched by professionals; many others will be triggered by unsuspecting civilians. Over the last 20 years, these weapons have claimed more than 112,000 casualties, roughly half of them children.

Concealed explosives – the remnants of drug wars and civil wars and fronts long forgotten – don’t vanish after treaties are signed. World War II lives on, for example, hidden in the sands of North Africa, says Professor Gerald Kulcinski.

Prof. Kulcinski is a highly sought-after expert who has been leading nuclear fusion energy research at Madison since 1971. With respect to his present work on near term applications of fusion energy, people who have expressed interest and support include men who have walked on the moon, foreign diplomats, Defense Department officials and CEOs of U.S. industrial firms.

He says that detecting clandestine materials in war or peace is a costly and hazardous business. The Pentagon has spent over $19 billion on the problem, yet the leading method remains bomb-sniffing dogs.

The military’s interest is clear. Improvised explosive devices (IEDs), or so-called roadside bombs, burst into public awareness during the U.S. wars in Iraq and Afghanistan, accounting for half of American combat deaths.

Outside the theater of war, concealed explosives – land mines, IEDs, unexploded ordnance, smuggled nuclear material – pose a danger to ordinary civilians too, says Kulcinski. The next catastrophe could lurk in a suspicious backpack, or in any one of the world’s 4,700 stadiums, or among the scores of shipping containers unloaded daily at ports of entry.

With support from WARF Accelerator, a project underway in the basement of the Engineering Research building could make explosives detection faster and safer.

Working in their specialized lab, Kulcinski’s team is developing a fusion neutron generator that is compact and light enough to be flown on a drone. The key concept is that when the neutrons encounter explosives, which contain a high amount of nitrogen, readily detectable gamma rays are produced.

They call the system the Red Rover Project.

It could work like this: A drone carrying the proprietary neutron generator flies ahead of a convoy, receiving radiofrequency power from a Humvee or other mobile source. The generator uses this power to produce the neutrons that will induce telltale gamma signals if an explosive is present.

(The system could also include a relay drone to relay power in the event of hilly or complex city terrain.)

“We know that if we can generate 100 million neutrons per second with D-D [deuterium-deuterium] fusion, then we can detect explosives down to a meter below the surface,” Kulcinski says. “We’re demonstrating that.”

Moreover, the system may also be able to identify the type of explosive based on its unique chemical ‘fingerprint’ – useful information for whoever is sent to dispose of the explosive.

Support from WARF Accelerator is helping the team shrink the size of the neutron generator and show that it can detect an explosive in the laboratory. This validation will help the project attract additional partnerships and advance the Red Rover Project to the prototyping stage.

In 2010 about 100,000 land mines were removed but 2,000,000 were planted.
“All the physics have been solved,” Kulcinski says. “It’s the engineering that still has to be solved. That is, taking a 10 kilogram payload, a 10 kilowatt power source and a drone that flies six feet off the ground at several yards per second and put it all together.” Kulcinski and two colleagues, Emeritus Research Professor John Santarius and Dennis Hall, a security expert, are currently refining a business plan and are in discussions with an industry collaborator in the Madison area. “We’re making alliances,” he says.

Interest is high because the potential security applications are countless.

“Say you want to scan the stadium in Green Bay, before the crowd comes, to see if anyone’s planted a bomb in a trash can,” says Kulcinski. “[With the new system] you could do it very quickly. The drone can fly around inside the stadium and check all the places where somebody might conceal something.”

Of course, fusion is a powerful muse (e.g., work temporarily slowed pending reconstruction of a four-foot-thick neutron shield wall needed to protect students and staff). In the course of a career spent exploring its power and potential, Prof. Kulcinski, emeritus now, has mentored more than 60 advanced-degree students.

Today, leading a project like Red Rover, the stakes seem higher than ever – maybe someone’s life or death.

“We have more ideas than we can solve,” Kulcinski says of his research enterprise. “It’s a problem that we deal with all the time.”

Students preparing and testing an experimental fusion neutron source.

In Memoriam
Tim Rueth
1960-2019

In May, WARF lost a friend, mentor and collaborator. Tim Rueth was an investor and consultant to high-tech startup companies, entrepreneurs and universities. A longtime Catalyst in our Computer Science area, Tim served as a mentor to many, and used his expertise in technology commercialization to make a difference at UW and beyond.

We will miss his friendship.
NEW PATHWAY:
High value plastic precursors called diols are widely used in paints, coatings, adhesives and other goods – part of a $6 billion annual market. Today, these chemicals are derived entirely from petroleum, but a UW–Madison team wants to change that.

Kevin Barnett, Kefeng Huang and Prof. George Huber (chemical and biological engineering) have pioneered a ‘green’ chemical pathway for producing diols from biomass. They have formed a company (Pyran) to take this technology to the next step, and been awarded substantial grant funding.

COMPUTER SCIENCE AND ENGINEERING

SUB-5:
Block copolymer lithography is one of the most powerful technologies of the digital era, allowing millions of nanoscale components to be fabricated on a single chip. There is an increasing need, specifically in the semiconductor industry, to achieve ever smaller dimensions and enable fabrication of sub-5 nanometer features.

A project by Padma Gopalan (materials science & engineering) aims to find a solution that, to date, has evaded industry giants such as Intel and Micron. Her team has identified and scaled up a novel synthetic route, resolving essential challenges in the process. Stay tuned.

SWITCHING IDENTITIES:
A team led by Chang-Beom Eom (materials science & engineering) is on track to advance a material that could lay the groundwork for ultrafast electronic devices such as the cellphones and computers of the future. Incredibly, the new material can transition from a transmitting metal to a nonconducting insulating material without changing its atomic structure.

This research was featured in the journal Science last year. Looking ahead, the team is reaching all milestones, including optimizing growth conditions and raising the operating temperature of the device above room temperature – a critical step towards commercial viability.

SAVE THE DATE
11.5.19

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- WARF Innovation Awards, recognizing early stage innovation

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For more information about available WARF technologies, please contact the technology commercialization team at accelerator@warf.org.