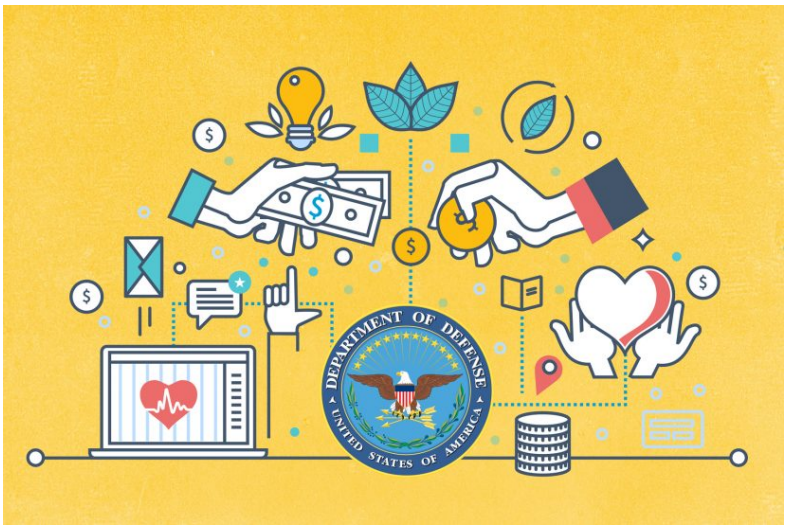
Science/Technology University

Department of Defense funds futuristic USC research in electronics and beyond

USC engineers and scientists will use $169 million in Multidisciplinary University Research Initiative grants to make "living" devices and illuminate mysterious chemical reactions

BY **Greg Hardesty** JUNE 8, 2018



MURI grants, which support research aimed at technological advances bridging scientific disciplines, are difficult to get. (Illustration/USC staff)

They're bringing together computers and biology, creating half-living, half-electronic devices. They're also looking for molecules that could result in propellants that ignite far more powerfully than ever before. And that's just for starters.

USC scientists and engineers are pushing boundaries, and now they've been recognized for their creativity. The U.S. Department of Defense (DOD) has thrown its support behind four projects based at the USC Dornsife College of Letters, Arts and Sciences and the USC Viterbi School of Engineering. USC researchers this year won a combined $169 million in Multidisciplinary University Research Initiative grants, highly competitive research awards that last five years.

“It’s a really great sign that so many of our researchers were successful in their MURI applications,” said recipient Stephen Bradforth, professor of chemistry at USC Dornsife. “These research projects represent innovative, out-of-the-box type thinking.”

Past Multidisciplinary University Research Initiative grants have yielded such advances as the integration of computer algorithms with sensors to help counter vision impairment and the use of self-assembling materials to create microscopic — nanoscale and microscale — structures, the DOD said.

The following are brief descriptions of the projects:

‘Livtronics’

Moh El-Naggar, associate professor of physics, biological sciences and chemistry

“Livtronics: Living Electronics for Biologically Enhanced Sensing, Computing and Signal Transmission”

Moh El-Naggar has a dream: developing a new class of devices he “living electronics.” The idea is to combine biological and synthetic electronics, using the strengths of each.

One place to start is the cell. Cells can reproduce themselves and are efficient at converting and transmitting energy and carrying out tasks.

“Biology is very robust and self-healing,” said El-Naggar, who holds the Robert D. Beyer Early Career Chair in Natural Sciences.

The aim is to combine these advantages with familiar electronics — such as computers — and the things they do well, such as calculations.

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>
> Moh-El Naggar

“We’re looking at seamlessly integrating a cell into more traditional electronics we already know how to build,” he said.

Molecules that can cause a big bang

Stephen Bradforth

“Predicting and Validating Pathways for Chemical Synthesis”

Bradforth will use computer deep-learning methods to search for new ways of making highly energetic molecules that could result in new types of propellants.

“The DOD is interested, essentially, in high-energy molecules,” Bradforth said. “What the MURI team wants to do is produce highly strained molecules, where the molecular structure is not where it wants to be. That creates a situation like a coiled spring — substantial additional potential energy can be released on ignition.”

Bradforth said his team will be looking for “totally new pathways and trying to explore synthetic chemistry space that hasn’t been explored before.”

His role as physical chemist on the team will be to verify the efficacy of new pathways to synthesize target molecules that novel computer algorithms predict will work.

Science at the surface

Jahan Dawlaty, associate professor of chemistry

“Molecular-Scale Studies of Liquid-Solid Interfaces in Electrochemical Processes.”

This project is all about surfaces — and the chemical reactions that can happen there. Turns out that they’re important to a variety of tools and products that people use every day. In electrochemistry, chemists have lots of questions about what happens where a solid and a liquid meet — and where electricity is coupled to chemical reactions. These interfaces are challenging to understand since they require bringing knowledge of chemical reactions and the physics of solids together, Dawlaty said.

The actual action happens at a skin between the two surfaces that is only a few molecules thick.

“It’s hard to measure, model and control chemistry in such thin layers,” said Dawlaty, who noted that such research could lead to practical applications in various electrochemical areas, including fuel cells, batteries and electrolyzers.

Collusion and competition

Milind Tambe

Helen N. and Emmett H. Jones Professor in Engineering and professor of computer science and industrial and systems engineering

“Multi-Scale Network Games of Collusion and Competition”

Tambe is examining the parties involved in the Syrian war, and how their dealings shine light on networks of collusion and competition.

“Our goal is to make inferences about, and ultimately influence, strategic behavior of actors in network contexts,” Tambe said.

Amy Blumenthal of the USC Viterbi School of Engineering contributed to this story.