AN INTERDISCIPLINARY HAT TRICK

Do you believe in research miracles? YES!

BY **MANASEE WAGH**
AND **CHRIS LARKIN**

"This is an impressive feat for any university and a testament to the interdisciplinary research teams that developed the three winning proposals."

—Alan Snyder

ACROSS AN ARRAY OF COMPETITIVE ENDEAVORS THAT INCLUDE SCRABBLE, CRICKET, AND ICE HOCKEY, the scoring of three goals in a single contest is met with much fanfare.

As any faculty researcher will tell you, grant writing is indeed a contact sport, and three 'goals' in a single year is equally applause-worthy.

Very few research funding opportunities are as cut-throat as the National Science Foundation's annual Major Research Instrumentation (MRI) program. In the 2017 MRI cycle, Lehigh University took three shots on goal—and buried all three in the back of the net.

This is an impressive feat for any university, says Alan Snyder, Vice President and Associate Provost for Research and Graduate Studies at Lehigh, and a testament to the interdisciplinary research teams that developed the three winning proposals.

"Success requires these teams to convince grant reviewers that this equipment, which is often highly customized, is thoughtfully configured, will be in the hands of experts who can manage and maintain it well, and that it will advance the research of a number of investigators," Snyder says. "Development of such shared core facilities, accessible to multiple research teams and our colleagues from industry concerns and government agencies and labs, fosters collaboration and facilitates further research progress across disciplines and organizations."

PROPOSAL #1
Environmental X-ray Photoelectron Spectrometer (E-XPS)

THE TEAM
Dr. Israel Wachs, Himanshu Jain, Jonas Baltrusaitis

The Environmental X-ray Photoelectron Spectrometer (E-XPS) performs nanoscale surface analysis of materials in a wide variety of environmental conditions, a technological feat in its own rite. Ordinarily, says Wachs, it is very difficult to place samples in realistic conditions.

"Advanced functional materials possess unique surfaces and interfaces that find widespread use, such as generation of clean H_2 fuel via photocatalytic splitting of water, solar energy storage, semiconductors, wear of materials' surfaces, biofuel production, water treatment, biomolecules in their native wet environments, and medicine," says Wachs. "Successful applications require detailed information about the surfaces and interfaces of these materials in different environmental conditions."

"The E-XPS will give Lehigh researchers unparalleled access to surface elemental composition and chemical state information about such interactions in different environments—gas-solid, liquid-solid, and liquid-gas—over a wide range of temperatures. This is incredibly sophisticated equipment, and it is difficult for most universities to obtain such equipment without support like this from the NSF."

According to Wachs, use of the E-XPS for surface analysis will overcome shortcomings of traditional XPS instrumentation that can only operate under ultra-high vacuum pressures. With this new "near ambient pressure" capability offered by the new generation of E-XPS spectrometer, Wachs envisions research activities with the potential to advance the fundamental science and design of advanced functional materials.

"Many materials' properties and functions are determined by the arrangement of their atoms—the composition, structure, and electronic properties at the materials' surface," Wachs explains. "With the E-XPS, Lehigh researchers have a more powerful tool than ever before in examining and understanding the molecular structure at the top layer of a material."

PROPOSAL #2
High Pressure Spatial Chemical Vapor Deposition (HPS-CVD) Reactor Development

THE TEAM
Nelson Tansu, Siddha Pimputkar, Jonathan J. Wierer, Volkmar Dierolf, Nicholas C. Strandwitz, Renbo Song

An interdisciplinary faculty team associated with Lehigh's Center for Photonics and Nanoelectronics (CPN) is using its MRI support to create a High Pressure Spatial-Chemical Vapor Deposition (HPS-CVD) reactor, intended to be ready to grow new materials beginning in January 2019. The instrument will be managed by CPN's technical staff, and it will be housed in the Smith Family Laboratory, a 12,000 ft^2 facility that enables semiconductor epitaxy, nanofabrication, and advanced device characterization.

This system will be enable new capabilities in material synthesis that includes growth under extremely high-pressure conditions, growth under extremely high temperatures, the ability to integrate new elements, and the ability to integrate highly dissimilar materials.

According to Tansu, core Lehigh faculty working in III-nitrides and new oxide/oxynitride wide bandgap semiconductors are highly productive, with more than 90 journal papers published at Lehigh over the past 5 years.

"We are truly excited to have the opportunity to build a next generation reactor with the capability of growing new materials under extreme conditions," says Tansu, who also serves as director of CPN. "A reactor that can grow unconventional III-nitride semiconductors, oxynitride materials, and potentially integrate them with other 2-dimensional layered materials, will allow us to make novel and promising materials, to answer fundamental questions about them, and to use them to build groundbreaking devices."

PROPOSAL #3
500 MHz Nuclear Magnetic Resonance (NMR) Spectrometer

THE TEAM
Kerney Glover, Damien Thevenin, Bryan Berger, Nicholas C. Strandwitz, Renbo Song

Nuclear Magnetic Resonance (NMR) spectroscopy is one of the most powerful tools available for the structural study of molecules. It is used to identify unknown substances, to characterize specific arrangements of atoms within molecules, and to study the changing interactions between molecules in solution.

Kerney Glover's lab has recently improved the signal-to-noise ratio of its existing 500 MHz NMR with the addition of a so-called "cold probe" that uses liquid helium to cool the system's electronics. With support from the MRI grant, the team is adding a new user console to make the device even more powerful.

"The NMR allows you to get information on every single atom," Glover says. "For protein work, this added sensitivity is very, very important and represents the latest platform."

Glover specializes in the structure of membrane proteins, specifically caveolin, found on the surface of cells and involved in making special pits, called caveolae, in the cellular membrane.

"This protein is implicated in heart disease, cancers, muscular dystrophy and Alzheimer's' disease," he says, "so developing our understanding of caveolin is very important."

Glover adds that the instrument will be available to students and researchers who need to examine materials on such a small scale."This ensures that the impact of the NSF's investment is as significant as possible," he says.