Welch Funding Helps Chemists Pursue New Research Directions

Michael Downer

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Principal Investigator
The University of Texas at Austin

Mike Downer's major research interest is chemistry at the surfaces of materials and at the interfaces between materials.

"This is the frontier where new things happen," he says. "Here you see types of bonding that don't occur elsewhere. It's also where new growth starts."

Currently his lab is studying surfaces and interfaces of semiconductors, including the growth of organic films on silicon substrates, and the bonding of so-called "high-k" oxides to silicon and gallium arsenide.

Dr. Downer is especially interested in what he calls nano-interfaces because of the unique bonding structures that occur there. One example is his extended study of silicon nanocrystals embedded in glass. Because of their small size, these tiny balls have a high percentage of interface area where unusual molecular structures create new and interesting properties. For example, unlike most forms of silicon, nanocrystals are efficient light emitters, which is an extremely useful property. Dr. Downer reports that nanocrystalline silicon holds the promise of unifying both electronic and light-emitting technologies under a single material system.

Powering his research is a suite of optical techniques he has developed or adapted over the past two decades with support from Welch funding. These techniques go by names such as second-harmonic generation, reflectance anisotropy spectroscopy, spectroscopic ellipsometry, Raman scattering, photoluminescence and internal photoemission spectroscopy. A rule in his lab: Never rely on a single technique. When used together, the tools allow him and his students to probe for complementary information at the interfaces in a non-invasive manner.

Dr. Downer did his graduate work with Nicholas Bloembergen at Harvard, who was awarded the Nobel Prize for his pioneering work with nonlinear optics. Dr. Downer was one of the first scientists to bring femtosecond lasers to UT when he joined the faculty in 1985 following his postdoctoral work at Bell Laboratories. He reports there is now a large ultrafast community in chemistry, physics and engineering at the university.

"Welch has consistently supported my work since I qualified for my first grant a few years after coming to UT," Dr. Downer says. "That is one of the virtues of Welch funding. As long as we remain productive, keep generating new ideas, developing new techniques and successfully training our students, the Foundation's support gives us considerable flexibility to follow our noses and go where the research leads us."

After 25 years in Texas, Dr. Downer confides that he is finally comfortable admitting he's a New York Yankee. "I got here as fast as I could," he chuckles. He says growing up in Rochester, a center for optics, planted the first seed of his ultimate research direction. Today, he continues to develop and combine linear and nonlinear optical techniques in new ways, creating tools that allow him to explore novel properties at the interface frontier.

David J. Mangelsdorf

Principal Investigator
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David Mangelsdorf calls himself a ligand hunter. Starting with his graduate work on vitamins A and D, he has been exploring orphan nuclear receptors that bind to DNA and the ligands that activate transcription factors to turn genes on. To date, he has discovered three new receptors.

The first receptor, called LXR, helps maintain