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Experimental Program to Stimulate Competitive Research

UNO Researchers Pioneers in Nanotechnology

This is the second of a three-part series of articles on the three university teams that headed the Consortium of nine universities collaborating on micro- and nano-scale science and technology research under a $9 million National Science Foundation EPSCoR grant in 2001. At that time, the largest award received by the Board of Regents' Louisiana EPSCoR program, it was matched with $3 million from the Board of Regents Support Fund and $3.8 million pledged by the participating universities and private industry.

Thinking small – *very* small – has earned some University of New Orleans' researchers international recognition for their early investigations in nanotechnology, a revolutionary field that will impact every area of science and technology.

Nanotechnology is the creation of functional materials, devices, and systems through the control of matter on the nanometer-length scale. A nanometer is one billionth of a meter and one nanometer is 100,000 times smaller than the diameter of a human hair. Looking at it from another perspective, there are as many nanometers in an inch as there are inches in 400 miles.

One example of the possibilities of nanotechnology is a computer that has more memory, won't lose your work with a sudden power outage, and turns on instantly. Another – this one in the field of medicine – is the ability to determine a cellular abnormality or disease at an early stage of development and deliver a drug to a specific site on the body.

"UNO Advanced Materials Research Institute (AMRI) researchers have been actively involved in nanotechnology for over eight years, making them among the first in this cutting edge of research, well before it became a hot topic 'buzzword' within the past four years," says AMRI Director Charles J. O'Connor. "We were curious about what happens to magnetic materials when magnetic grains are made smaller, so we initiated some research. Our examinations resulted in a grant from the Department of Defense Advanced Research Projects Agency (DARPA), which in turn led us into an overall exploration of nanotechnology."

There is one big problem in creating materials at the atomic and molecular levels: they exhibit special physical and chemical properties that can be very different from those in their bulk material form. "The laws of classical physics no longer control them. Because you are instead confronted with quantum mechanics, which has a different set of rules regarding how materials will behave, new properties and phenomena can occur," explains Dr. O'Connor.

A promising strategy to exploit the quantum challenge by merging new developing techniques – the field of spintronics with e-beam nanolithography – is also under investigation by AMRI through funding from another DARPA grant, this one for $1.6 million.

Dr. Silvia De Paoli Lacerda, a post-doctoral researcher from Sao Paulo, Brazil, working in the BioMagnetics laboratory of the University of New Orleans Advanced Materials Research Institute.

"Although the use of electricity has been around a few hundred years, only electrical charge has been utilized in electrical current. The electron's spin, the other property of electronics, has not been used," says Dr. O'Connor. "Exploitation of the spins, however, dramatically increases the capability of electrical circuits in terms of memory, increased processing speeds and decreased power consumption. Additionally, in the proper structures, they are not volatile."

"What we do in nanolithography is first look at devices operating on the micrometer scale and then see how or if they will operate on the nanometer scale. Our focus is to develop novel nanometer scale miniature electronic systems and devices that are superior to conventional devices currently available on the market with applications in nanotechnology, bio-nanotechnology, systems for drug delivery, bio-sensing, nano-bioelectronics, and nano-assembly processing of more complex systems."

This research is an outgrowth of AMRI information technology and nanomaterials investigations during

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the past five years under a $9 million National Science Foundation (NSF) EPSCoR grant for a consortium of nine Louisiana universities, notes Dr. O'Connor. It was while working on this grant that AMRI scientists first turned their attention to biomedics.

More recently, a Louisiana consortium directed by AMRI received a three-year $6.1 million DARPA grant for biomagnetics research. A direct result of that same NSF EPSCoR award to a consortium of nine Louisiana universities, the grant is a collaborative effort with the LSU Health Sciences Center in New Orleans (LSUHSC) and the J. Bennett Johnston, Sr. Center for Advanced Microstructures and Devices (CAMD) in Baton Rouge.

UNO is working on the development of functional biomedical nanoparticles; CAMD on a micro fluidic sensing device that uses nanoparticles to detect biochemical agents; and LSUHSC is looking at ways to functionalize magnetic nanoparticles for biomedical/clinical applications.

"At AMRI we are developing drug-functionalized magnetic nanoparticles that can be delivered to a targeted area via magnetic manipulation and eliminate the side effects associated with systemic drug delivery," says Dr. O'Connor. "A good example is chemotherapy, which basically poisons the whole body, hoping that the tumor dies before the body. With nanomagnetic delivery, we can target the drug directly to the tumor and side effects to the rest of the body will be minimal." Potential applications of nanophase magnetic materials also include ultra high-density magnetic recording media, quantum computing circuits, and smart materials.

Another group of AMRI researchers has been assembled into a Nanoscale Interdisciplinary Research Team (NIRT) funded by NSF. Directed at the integration of nano-elements into devices with applications in electronics and telecommunications, it too is a direct result of the NSF EPSCoR consortium grant.

A multidisciplinary materials research institute, AMRI combines the interests of academic, government and industrial scientists working on collaborative research projects. It has an inventory of over $4 million of specialized materials research instrumentation to carry out its research programs.

Dr. O'Connor, UNO's Distinguished Professor of Chemistry, has directed AMRI since 1997. He developed a summer outreach program at UNO for high-school students, high-school teachers, and underrepresented minority undergraduates and is directing an effort to develop a collaborative Ph.D. program in Materials Science and Engineering between UNO, Louisiana State University and A&M College, and Southern University and A&M College. The recipient of 16 grants for a total of $29.6 million from federal, state and private agencies, Dr. O'Connor has obtained a U.S. patent for the fabrication of unique nanomaterials.

The three lead teams of the Consortium of nine universities collaborating on micro- and nano-scale science and technology research under a $9 million grant from the National Science Foundation EPSCoR grant were housed at the University of New Orleans, Louisiana Tech University and the LSU Health Sciences Centers in New Orleans.

The remaining members of the Consortium were Grambling State University, Louisiana State University and A&M College, Southern University and A&M College, Tulane University, University of Louisiana – Monroe and Xavier University. A number of private companies also participated.

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