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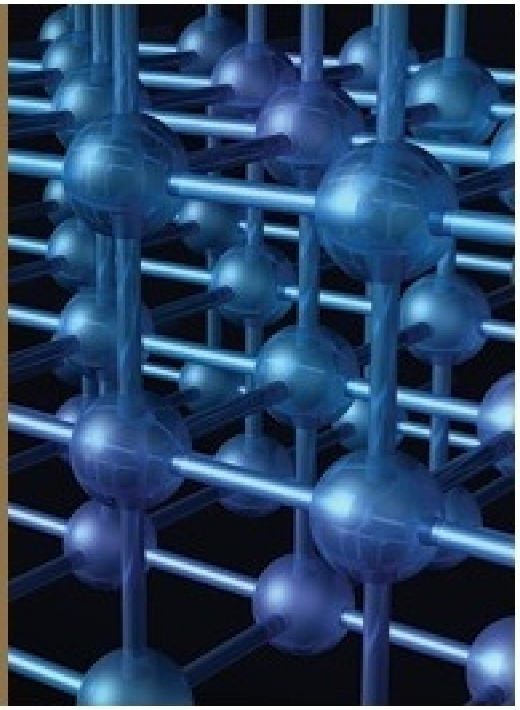
RESEARCH

Science, Scholarship & the Arts at the University of North Texas

ADVANCING NANOTECHNOLOGY

AT ONE-BILLIONTH OF A METER, SCIENTISTS CREATE ON THE Cutting Edge

By Randena Hulstrand



Some of nature's most complex relationships begin at one of the tiniest scales. Research at the nanometer level — one-billionth of a meter, the width of three to four atoms — is leading to new materials and technology transfer applications that can solve some of the big issues of our day in areas such as bone repair, drug delivery, chip design and solar cells.

At the forefront of this research are University of North Texas scientists whose interdisciplinary approach to nanotechnology combines experimental science and computational research with state-of-the-art facilities for computer simulation and modeling. Devices based on their studies will save time and money — and perhaps lives.

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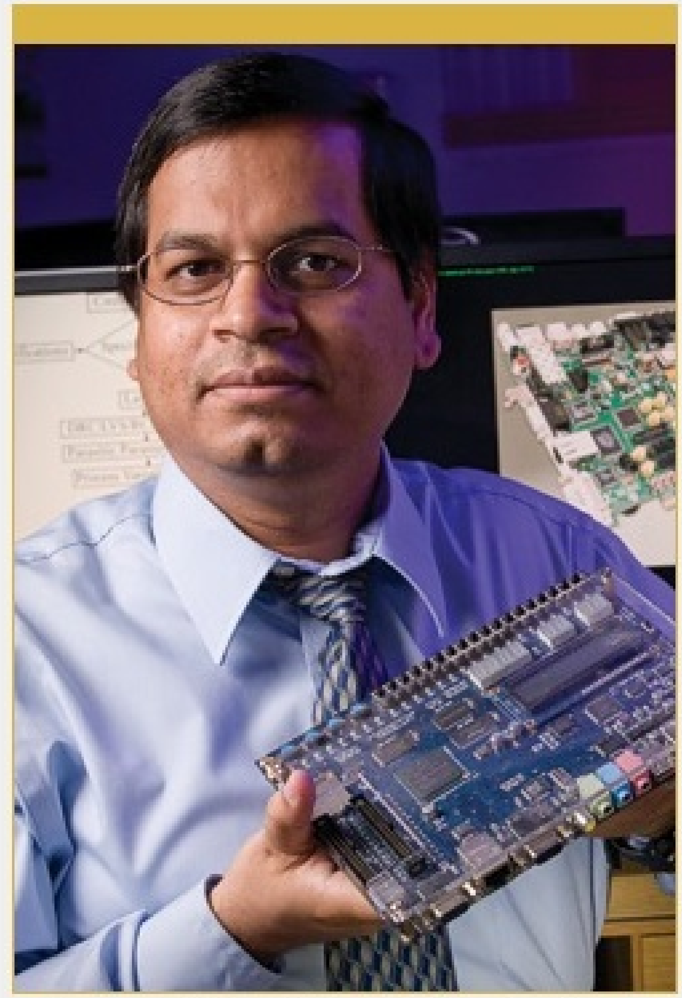
Nanoelectronics of the Future

Keeping up with the demands of technology-savvy consumers has semiconductor companies such as Texas Instruments, Intel Corp. and Apple working to meet needs 10 to 20 years in the future. Saraju Mohanty, associate professor of computer science and engineering, is designing application-specific hardware these companies and customers will want.



Saraju Mohanty researches hardware design and is working to create batteries with a longer life. He holds two patents for innovative chip technology.

Photo by: Jonathan Reynolds

Mohanty, director of UNT's NanoSystem Design Laboratory, and student researchers collaborate with major industry players such as Intel using the International Technology Roadmap of Semiconductors. The goal is to invent and design consumer electronic "challenges" (10 years ahead) and "grand challenges" (20 years ahead).

With about $1 million in grants from the National Science Foundation and the Semiconductor Research Corp., Mohanty keeps pushing the boundaries of chip processors' capabilities in the booming technology industry that includes cell phones, laptops and MP3 players. He researches hardware design using computer aided design for low-power, high-performance nanoscale VLSI (very large-scale integration), the process of creating integrated circuits by combining millions of transistor-based circuits into a single chip.

A single transistor in a circuit has hundreds of parameters, and a chip like an Intel i7 has 800 million transistors, Mohanty says, so to simulate an individual test of each parameter is an impossible task unless you reduce the time of the simulation process.

"Modeling uses extremely fast, high-end equipment to run the simulations, so we can see what we need to design better," he says. "Different phones have different circuits, batteries and plastics, so we need different methodologies."

He also is working to create batteries for consumer electronics that have a longer life and don't need frequent charging, an industry roadmap "challenge." The CAD tools at his lab in Discovery Park, UNT's nearly 290-acre research park, include two Intel Quad-Core Xeons, computer and high-end server systems with several terabytes of storage and hardware simulation tools. Through nanoscale device and system modeling with these tools, he's studying how to reduce power leakage while the device is still in the design phase. Eventually, during the manufacturing phase, Mohanty's group will use a new clean room facility at Discovery Park.

"Our goal is batteries that require charging once or twice a week rather than a couple of times a day," he says.

Research Collaborations

Mohanty has collaborated with Priyadarsan Patra, architect and scientist at Intel Corp., for several years on low-power circuit design and synthesis, leakage and reliability modeling, and network-on-chip research.

"The design challenges of today's advanced semiconductor devices involve such extreme dimensions as the 1.2 nanometer thin oxide, a layer only a couple of atoms thick," Patra says. "That makes Saraju's research collaboration mutually beneficial for UNT and Intel and valuable to tackling some of these issues."

Mohanty also holds two patents for innovative chip technology — digital picture images to securely store biometric personal data such as for electronic passports, and a video processor that can process network and multimedia directly to cell phone or computer, such as direct secure streaming of video without using high-performance computing. And he's published research on a drug delivery innovation that would allow a chip in a patient's body to "electro-chemically deceive the brain" out of symptoms, communicate with doctors or make emergency calls.