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**An image to accompany this story can be found here.**

# BUILDING NEW TECHNOLOGY, ONE ATOM AT A TIME

## *Assistant Professor of Physics Wins NSF Career Award*

By Dave Mosher

Jay Gupta 's new $500,000 award will aid studies of atomic structures and even help inspire the next generation of researchers in science, technology, engineering, and mathematics.

Gupta's funding comes from the National Science Foundation (NSF) as a Faculty Early Career Development (CAREER) award , which is given to junior faculty who best integrate research and education. The assistant professor of physics at Ohio State University is the 54th CAREER recipient since 1996 and, in total, the university has been awarded more than $15 million through the program.

On the research end, Gupta will use the funding to help his lab study structures at an atomic level using a scanning tunneling microscope, or STM. Gupta says he will also use Web-based tools for educational outreach programs for underrepresented groups. Hopefully this will increase students' interest in science, technology, engineering, and mathematics.

Jay Gupta

Since the first computer was developed, improving performance has heavily depended on creating ever-smaller components. By investigating the behavior of electronic structures and materials

on an atomic scale, Gupta hopes to improve nanotechnologies such as flexible circuit boards and quantum computers.

The effort to make nano-scale devices a reality is a tall order. Researchers believe that nano computers of the future, for example, won't rely on the charge of electrons in the materials—instead they'll use a quantum property of the electrons called spin to store and process data, resulting in what scientists call a "spintronic" computer.

But to even begin to build spintronic devices, Gupta said science needs a better understanding of the materials they could be made out of. "The smaller a clump of matter is, the more quantum mechanics is needed to predict its behavior," he said. On larger scales, an element like niobium can act as a superconductor under ultra-cold temperatures. Superconductors are a material that freely allows electrons to pass through it without resistance, unlike copper wires in a home. "But when you only have a cluster of few niobium atoms, quantum mechanics predicts that it's not superconducting," Gupta said.

To study such behaviors with atomic precision, Gupta and his team use STM, which in simple terms operates like a glorified record player. The STM's "stylus" has a tip of just one atom and hovers over the surface of a material within a nanometer—a distance about 80,000 times thinner than a human hair. When a voltage is applied between the tip and material's surface, electrons "tunnel" into the tip to create an electrical signal. A computer records the variation and, after a few minutes of scanning, a picture of a surface is produced at an atomic resolution.

But the STM can also be used to shuffle individual atoms or molecules from one place to another. "In a way, it's kind of like being a toddler playing with atomic building blocks," Gupta said, "and that's how we create nano-scale structures to study."

Gupta said he hopes to develop Web-based software to share the STM with students hundreds of miles away. "But for now I'm participating in a program at COSI where high school students across the country can ask me questions about my work," he said.

Gupta joined Ohio State in 2004, and said the award will help him and his laboratory staff stay focused on their research goals in addition to inspiring the next generation of physicists. "I heard I had received the award on the same day the Cardinals won the World Series, and I'm from St. Louis," Gupta said. "So that was a fantastic day for me."

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Contact: Jay Gupta, (614) 247-8457; jgupta@mps.ohio-state.edu

Written by Dave Mosher, (614) 247-8362; mosher.46@osu.edu