# Physics goes small…really small

Nanotechnology. It's the buzzword inside practically all research universities, industries, and government and commercial laboratories these days.

We use the word a lot, but what are we talking about? Loosely defined, nanotechnology is the manipulation of materials in such tiny dimensions that they are measured in nanometers, or billionths of a meter.

A number of faculty members across disciplines within the College of Science and from other colleges within Virginia Tech are involved in nano-related research. Below are examples of three such researchers in the physics department. All three came to the university recently as part of a unique cluster hiring process in which experts across disciplines are hired to work collaboratively in combined research areas, in this case nanoscience.

**Giti Khodaparast**
The Khodaparast research group is probing magneto-optical phenomena important for nanotechnology to improve functionality of electronic devices such as transistors, lasers, and computers.

The current semiconductor-based devices are functioning mainly on the basis of manipulation of electrical charges (positive and negative). We know that carriers, in addition to their charges, have another identity called spin, which gives scientists an extra parameter to manipulate.

In order to make devices using both spin and charge, it is important to understand how these two identities interact with their host materials and with external fields, such as light and magnetic field.

Khodaparast's group is focused on understanding properties of carriers and spins in structures based on narrow gap semiconductors (ferromagnetic and non-ferromagnetic), which have unique properties, including high carrier mobility.

"I'm using time resolved magneto-optical techniques to understand charge/spin dynamics," Khodaparast said. "This has a number of potential applications, such as manufacturing of computer storage material which is non-volatile."

**Kyungwha Park**
The explosion of the information age has driven mega-scale efforts in the past decade to miniaturize electronic devices in order to store an ever-increasing amount of information.

These miniaturized devices are highly sensitive to surrounding environmental factors because of their extremely small size. That's where Kyungwha Park's research comes in to the big picture.

She and her research group are interested in understanding environmental influences on important physical and chemical properties of nanoscale magnetic molecules and nanoparticles.

“Our research is crucial to utilize the nanoscale molecules and nanoparticles as miniaturized devices,” Park said.

Park conducts high-performance computer simulations on these nanoscale systems using the Virginia Terascale Computing Facility (System X) and Linux computer clusters.

**Vicki Soghomonian**
Vicki Soghomonian, a materials scientist, is currently studying how electric charges go from one place to another in biological systems, especially in DNA strands.

Measuring and understanding the electronic properties of DNA has implications in various disciplines. For example, in the life sciences, the mechanism of charge transport may play a role in DNA repair.

“DNA further carries unique assembly promise due to the recognition properties of its complementary bases, which of course, form the foundation of genetic propagation,” Soghomonian said.

These assembly properties are exploited in nanotechnology by guiding and assembling nanoscale objects, such as nanoparticles, into active electronic devices.