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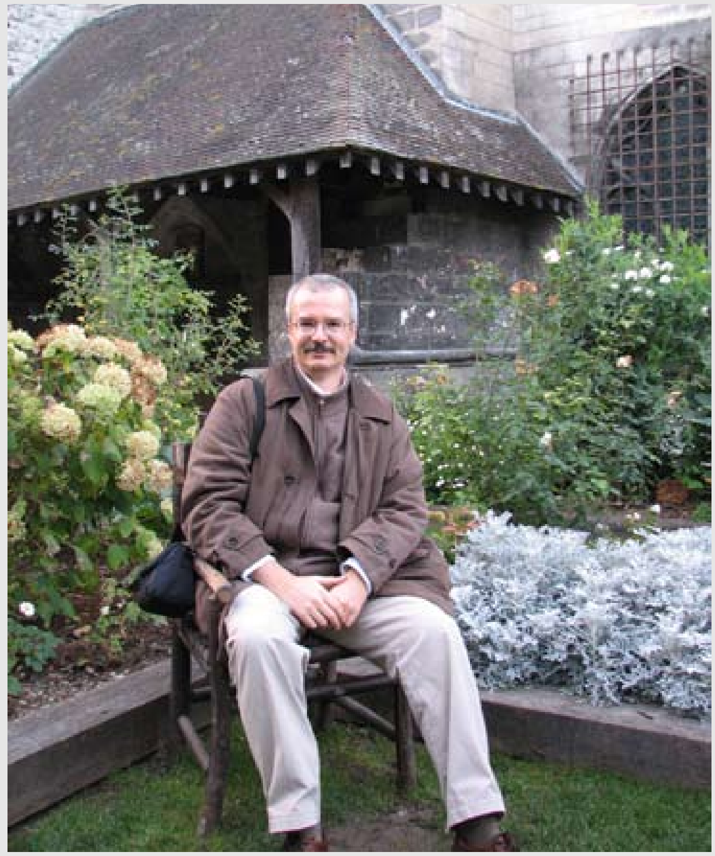
The Development of Nanotechnology: *An Interview with Dr. Andrei Stanishevsky*

By Kavita Nadendla

After taking Dr. Stanishevsky's Physics 201 course last year, I thought I would have no trouble interviewing him. As I made my way past the doors of faculty offices in Campbell Hall, I found my hands shaking as I neared room number 342. Students refer to him as "that Russian scientist who studies nanotechnology." Of course I would be intimidated to talk to him, in fear of sounding dumb or not understanding his work. However, I was glad to find Dr. Stanishevsky a welcoming man with a great sense of humor.



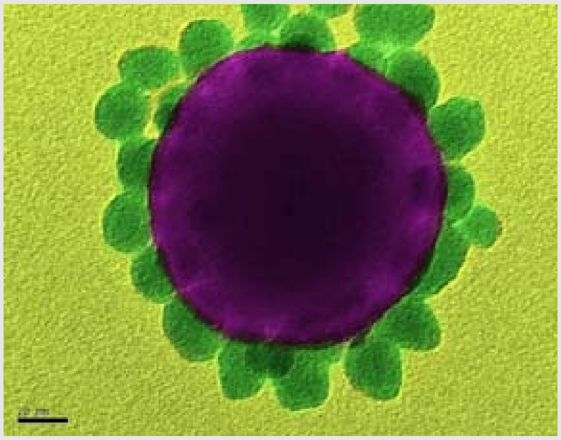
Dr. Andrei Stanishevsky has been at UAB for eight years as a professor in the Department of Physics in the College of Arts and Sciences. Coming from Belarus, Dr. Stanishevsky's educational and career path were different from the traditional path taken by students in the United States. His interest in academic teaching and research is what he would consider "genetic." Because both of his parents were university professors, he was exposed to the laboratory environment at a very young age. Even his middle school and high school curricula were geared toward the sciences. When explaining the rigor of his education, Stanishevsky said, "I was in a school that emphasized physics and mathematics. We had mandatory 4 years of chemistry and 5 years of physics, algebra in 4th grade, trigonometry in 8th, and calculus in 9th and 10th grades."

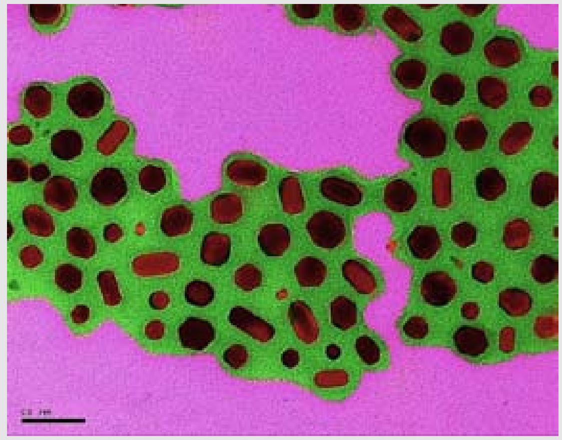
Because their school system does not have the equivalent of an undergraduate bachelor's degree, Stanishevsky entered a master's program right out of high school in a university in Minsk, Belarus, with a focus in electrical engineering, an extremely popular area of research at the time. Dr. Stanishevsky stressed the importance early lab experience had on his scientific endeavours. "I knew even before graduating from college that I wanted to do research. I started working in a lab my first year at college. Research experience gives students an upper hand when applying to graduate schools."

While completing his engineering degree, he became interested in microscopic systems research in materials and thin films, which is why he "decided to do research after graduation in an academic research center. It was mandatory to have two years of research or industrial experience before entering graduate school." At a research center of the Belarus Academy of Sciences, Dr. Stanishevsky finished his PhD in solid state physics.

During his PhD research, Dr. Stanishevsky teamed with many researchers in Europe, Japan, and the U.S. In 1996 he came to the U.S. after receiving a grant from the United States National Research Council to do post-doctoral studies at Penn State University. He worked later as a research scientist at the University of Maryland where he was exposed to nanoscience and nanotechnology. He eventually joined the UAB Department of Physics in 2002. When asked what made him choose UAB, he answered, "UAB is a relatively young university that is aggressively growing. It offers a lot of opportunities and I saw that I could do something new here. The facilities and fellow faculty are very good, so I saw a chance for good collaboration, which is an important part of research because you are expected to build a team to broaden your research interests."

Dr. Stanishevsky's current work focuses on two major directions related to the physics of materials – hard thin film coatings and nanoparticles. The study of hard thin film coatings is essentially the evaluation of new materials that simultaneously possess extreme hardness and toughness. This makes them attractive for cutting tools, biomedical implants, or parts of engines as examples. They are intended to survive extreme conditions in which harsh environments could destroy them. Stanishevsky's team produces thin film coatings using nitrides and carbides of different metals. "These materials can approach the hardness of diamond – the hardest material currently known. But they also possess properties diamonds don't, such as high thermal resistance, making them more ad-





Left: Transmission Electron Microscopy (TEM) image of a polymer nanosphere decorated with smaller (approximately 10 nm) silica particles.
Right: Transmission Electron Microscopy (TEM) image of gold nanocrystals with various shapes.

vanced than diamond in some applications." For this research focus, he has started various partnerships in Europe, including ParisTech (Cluny Center), France, Aalto University School of Science and Technology in Finland, and Technical University of Lodz in Poland.

His second major project deals with nanoparticle research – entities that range from 1-100 nm in size. There are special properties associated with the extremely small size of nanoparticles. Dr. Stanishevsky notes, "When the size of a particle is small enough, new electronic, optical, or chemical properties arise. This is attractive for numerous applications – composite materials, biomedical research as biomarkers, biosensors, drug delivery systems, and for monitoring and tracking states of living systems." His team designs the manufacturing of such particles from different semiconductors, metals, or ceramics with different shapes and dimensions to control unique particle properties in a broad range. An example being nanoparticles of calcium phosphate called hydroxyapatite, the major constituent of human hard tissues. He enlightened me that "up to 70% of our bones consist of nanoscale particles of hydroxyapatite held together by a collagen matrix. A potential application of synthetic hydroxyapatite nanoceramic-based composite material would be to build artificial bones or substitutes for repair of natural tissue."

In all areas of his research, Stanishevsky stresses the importance of research collaborations and partnerships on campus as well as abroad. Because scientific research has become an interdisciplinary effort, it's important to get many people from different backgrounds involved. Dr. Stanishevsky focuses on the material itself and its properties and his colleagues focus on how the particles behave in a certain environment, whether *in vitro* or *in vivo*. For example, researchers in UAB Medical School evaluate toxicity of artificially engineered nanomaterials and their effects on human organs. The Department of Biology tests the effects of the nanomaterials in the natural environment. Collaboration with the Chemistry Department and the Department of Materials Science Engineering is important for producing composite materials and nanoparticle systems for biological and chemical sensors. Several of Dr. Stanishevsky's international activities, funded by the National Science Foundation (NSF), initiated cooperation in new research ventures with several universities in France, Poland, and Finland. Through this cooperation, nineteen UAB undergraduate and graduate student exchange programs have been organized, as well as, scientific meetings in Europe, such as nanodiamond workshops in Poland and the Czech Republic, and a dual-PhD program with ParisTech (France).

Stanishevsky's ultimate goal is to "design new materials for improving the life of people and to bring those materials to production." He hopes to build nanoscale systems and nanoparticles useful in enhancing the service life of biomedical implants, processing tools, and biosensors. Essentially, the new nanomaterials can be used to make pure water out of waste through ultrafiltration. But for those expecting immediate results, he cautions "many projects are fundamental. They are not meant to develop a specific product, but to answer the question 'Why'. Why is the material toxic, what type of effect does it have on living systems, and how can we make it more reliable and long-lasting?"

With over sixty publications and all of his collaborative efforts, Dr. Stanishevsky helps motivate undergraduate students to pursue their goals in the scientific field. He challenges them to take on demanding projects in synthesizing nanoparticles and studying their biomedical applications. He encourages them to author articles in peer-reviewed journals and present at esteemed conferences in Europe. He has three key suggestions for undergraduate students considering research: 1) start early, 2) read a lot, and 3) keep a balance. Starting early gives students time to engage in different opportunities and to develop a primary interest. Because most fields are interdisciplinary, it is important for students to read both within and outside their major. Quoting Niels Bohr, Stanishevsky said that it's useful to work with people from different areas of research because they are not bound by the frames of that one subject. They could actually make a discovery faster than those who have worked in that one area for years because they are able to think outside the box.