SHRINKING DEVICES

INTEGRATING DIVERSE DIELECTRIC AND MAGNETIC MATERIALS

ASSOCIATE PROFESSOR ELENA SEMOUCHKINA engineers new electromagnetic devices and structures for the next generation of health care, communication, homeland security, and imaging systems.

Elena Semouchkina

"The critical requirement for faster wireless data transmission has prompted the creation of advanced materials and components for high frequencies," she notes. "There is a lot of interest in shrinking devices, too."

Semouchkina comes to Michigan Tech from Penn State, where she still serves as an adjunct professor. She holds three advanced degrees: an MS in Electrical Engineering, a PhD in Physics & Mathematics, both from Tomsk State University in Siberia, Russia, and a second PhD in Materials from Penn State.

"My goal is to find new ways to enhance functionality and reduce the size of devices by affecting wave propagation processes in their circuitry. This is done by integrating diverse dielectric and magnetic materials into the design." Her work on fabricating prototypes by using low-temperature co-fired ceramics (LTCC) technology has opened up opportunities to co-process diverse materials—something that makes those approaches feasible, she says.

Semouchkina has extensive research experience in several engineering fields, including electromagnetics, computational modeling and design, electronic and photonic devices, and materials. She plans to conduct graduate-level classes on new, emerging topics at the boundary of those different disciplines.

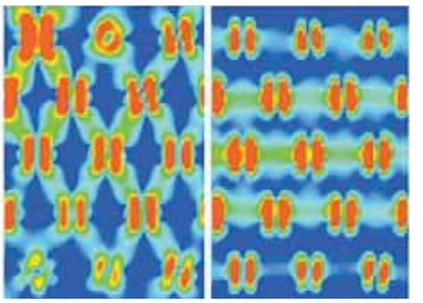
Her work integrates the fundamental study of electromagnetic wave interaction with nonuniform media. One recent project involved magnetic resonance imaging (MRI). "Currently with MRI, the alternating of magnetic fields is usually done with metallic coils. We tried replacing those cords with nonconducting ceramic materials." She studied this new form of MRI technology using zebrafish, a common and useful model organism for studies of vertebrate development and gene function. "MRI scans of the zebrafish conducted in this new way worked very well, resulting in a better, clearer image," she notes.

At Penn State, Semouchkina was a senior research associate with the interdisciplinary Materials Research Institute, and the Computational Electromagnetics & Antennas Research Laboratory, the latter within Department of Electrical Engineering. She was also associate professor in two additional departments—engineering science and mechanics, and materials science and engineering.

Designing and developing device prototypes is a priority for Semouchkina. She plans to do more of that type of research at Michigan Tech. "One of the reasons I was drawn here was the opportunity to use the Michigan Tech Microfabrication Facility. The fact that it is located within the ECE department is a plus."

Semouchkina received the Best PhD Thesis Award from Penn State in 2001, and was a 2004 recipient of the NSF Fellows Award in the ADVANCE Program: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers. She is an associate editor of *Antenna and Wireless Propagation Letters*. She is also co-organizer of the first-ever Women in Electromagnetics (WiEM), an annual international workshop, sponsored by the IEEE Antenna and Propagation Society.

Semouchkina's previous research at Tomsk State University, the Ioffe Physics-Technical Institute of the Russian Academy of Science, and St. Petersburg State Polytechnic University all included the investigation and development of solid-state devices, in particular, novel infrared MOS photodetectors.



Lattice-like pattern of coupled fields in a dielectric metamaterial.

Most recently, Semouchkina was an invited speaker at the third International Congress on Electromagnetic Metamaterials in London. Along with a group of Penn State researchers, she is working on the creation of an "invisibility cloak" a la Harry Potter. The theoretical basis of the "cloaking" phenomenon was formulated by Professor Sir John Pendry of the Imperial College in London, who presented a plenary talk at the congress. Semouchkina plans to continue her work on realizing the electromagnetic cloak at Michigan Tech using her recently announced project support from the National Science Foundation.