Charting New Nanomemory

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University of Arkansas physicists seeking to better understand the properties of ferroelectric materials at the nanoscale have discovered previously unknown properties.

Ferroelectric materials have invaded the everyday lives of most people – they populate watches, smart cards, television remotes and medical ultrasound devices. Because of those important properties, scientists want to be able to use these materials at the nanoscale, but researchers know very little about how these materials work.

Two University of Arkansas physicists have created computer simulations of ferroelectric nanodots to better understand the potential properties of these miniscule powerhouses. Their findings, reported in *Physical Review Letters*, include the discovery of previously unknown phases of the materials.

In 2004, Ivan Naumov, Laurent Bellaiche and Huaxiang Fu -- all physicists at the University of Arkansas -- determined that individual ferroelectric nanodots could form a vortex within the nanodot, where the charges swirl in almost a circular motion. Recently, Sergey Prosandeev, a UA research associate in physics, and UA collaborators revealed that inhomogeneous electric fields can switch the chirality of such a vortex -- which is important for technological applications.

Prosandeev and Bellaiche looked at how changing the nanodot's temperature, material and medium would influence the ferroelectric properties of the nanodot. Depending on the temperature and materials

from which the medium and nanodot are made, they found six different structural phases, of which two are well-known -- the classic ferroelectric and non-polarized states -- while the other four phases have never been seen before. Such new phases, and their inherent properties, may constitute an important step toward designing nanoscale devices with enhanced or original properties, including greater memory capacity.

“There is no terminology here in this area,” Prosandeev said.

The computer simulations that produce these results provide a road map for experimental physicists, Prosandeev said. The simulations help them know what to look for when they perform experiments.

Prosandeev is a research associate and Bellaiche holds the Twenty-First Century Endowed Professor of Nanotechnology and Science Education in the J. William Fulbright College of Arts and Sciences.

Source: University of Arkansas, Fayetteville