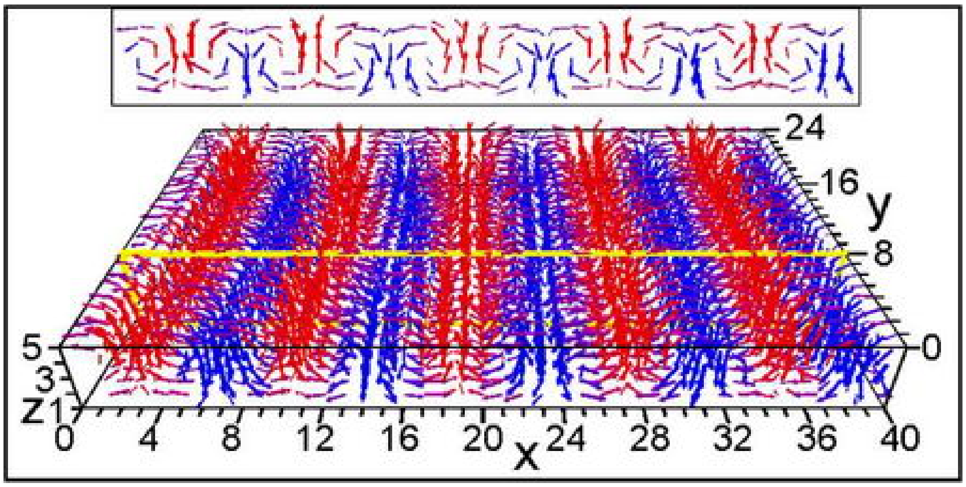
Tiny Bubbles in Nanofilms

March 17 2006



A group of theoretical physicists at the University of Arkansas has demonstrated that under applied voltages, thin films composed of technologically important ferroelectric materials form "nanobubbles," which have the potential to become a way to store lots of information in a tiny space. This could impact technologies from computers and portable electronics such as cell phones and MP3 players, to radio frequency identification devices.

Bo-Kuai Lai, Inna Ponomareva, Ivan Naumov, Igor Kornev, Huaxiang Fu, Laurent Bellaiche and Greg Salamo of the physics department report their findings in an upcoming issue of *Physical Review Letters*.

Lai and his colleagues use computational models to study the theoretical properties of ferroelectric ultrathin films. Ferroelectric materials currently are used in medical ultrasound and military sonar, as well as in cellular phones. These materials possess spontaneous electrical dipoles, or charge separations.

To determine the properties of ferroelectric ultrathin films, the researchers looked at a five-layer model of lead zirconate titanate (PZT). They looked at the dipoles within the film at different voltages, increasing the voltage until all the dipoles align parallel to the applied electric field.

At first, the materials contained lines of divergent dipoles in "nanostripes," showing a periodicity with 180 degree differences between the dipoles belonging to adjacent stripes. As the voltage is increased, the periodicity of the nanostripes remains the same, but the stripes themselves change, with one dipole orientation dominating over the other one.

As the voltage is increased, the surface layers at the top and bottom become more influenced by the voltage than the dipoles of the inner layers, creating opposite dipoles within the material that did not touch the top or bottom surfaces, forming "nanobubbles." These bubbles have the potential to store an incredible amount of information, according to Lai.

"These could be used to make memories," he said.

Computer memory is composed of two states, either a "1" or a "0," and all of the calculations, computations, RAM and ROM found in a computer are formed from combinations of these two states. The dipoles within the ferroelectric materials represent the same states, and a tiny "nanobubble" could store a lot of information using very little material.

Devices made at the nanoscale from PZT would, in theory, be cost-efficient, use less power and offer more memory in a smaller space than conventional devices.

Previous work has shown "bubbles" appearing with the application of a magnetic field in magnetic films, but the magnetic "bubbles" turned out to be too large and too slow to be useful as memory storage devices. The advantages of finding nanobubbles with an applied voltage include speed and small size.

"If you could deposit thin films, you could do mass production more easily," Lai said. Ferroelectric thin films have the potential to make electronic devices smaller and add more functions for consumers.

"It's a very fundamental understanding," said Lai of the nanobubble discovery. "But nanobubbles may have far-reaching applications in memory."

Source: University of Arkansas

Citation: Tiny Bubbles in Nanofilms (2006, March 17) retrieved 31 January 2025 from https://phys.org/news/2006-03-tiny-nanofilms.html