(continued from page 25)
between SrO and AlO_2 planes. Instead, all measurements to date have shown it to be insulating.

Jochen Mannhart and coworkers from the University of Augsburg and the Pennsylvania State University, using samples grown at relatively high oxygen pressures, found that one needs a minimum thickness of three unit cells of LAO deposited on the STO substrate before the interface will conduct electricity.[8] Such a steplike dependence of interface conductance on thickness of the LAO film is inconsistent with the presence of oxygen vacancies in significant numbers. Mannhart and coworkers were making a high-mobility transistor from the 2D electron gas at the STO/LAO interface. By applying a gate voltage to an initially insulating interface with just three unit cells of LAO, they could switch to a conducting state and back again.

For a different slant on the oxygen vacancy question, Alex Kalabukhov and his coworkers at Chalmers University of Technology in Göteborg, Sweden, studied the interface of STO with potassium tantalate ($KTaO_3$ or KTO).[9] In particular, they looked at an interface that was expected to have positive carriers if the dominant mechanism was the polar discontinuity. Hall measurements indicate that the charge carriers are negative; the result suggests the presence of oxygen vacancies.

Better characterization of the heterostructures can certainly help researchers understand what is going on at the interface, and a number of groups are working on such measurements. Techniques such as scanning transmission-electron microscopy can give clear pictures of the positions of the cations. As for the oxygen vacancies, current techniques to detect them are indirect and not yet capable of seeing vacancies below a certain density threshold.[10] It would also be nice to measure the charge distribution around the interface and, perhaps, to determine where the spins are. Are they indeed associated with the Ti^{3+} ions?

Strontium titanate was once touted as a substitute for diamond in jewelry, but it eventually lost out to other competitors. Perhaps the new interest in oxide interfaces gives a brighter shine to its future.

Barbara Goss Levi

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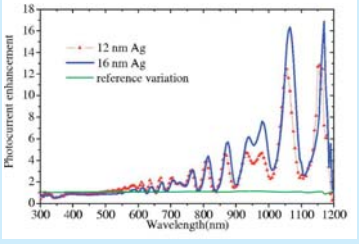
physics update

Supplementary material related to these items can be found at www.physicstoday.org.

Observing electron tunneling in real time. To escape an atom, an electron usually has to gain enough energy to climb out of the atom's Coulomb well. However, if the atom is bathed in an intense laser pulse, the pulse's strong electric field can lower the confining potential enough to allow the electron to tunnel to freedom. That hypothesis, proposed in 1965 by Leonid Keldysh, has now been verified, thanks to physicists' recent ability to control light on the time scale of electronic motion in atoms: attoseconds. Matthias Uiberacker of the Ludwig Maximilians University of Munich, Germany, and his collaborators blasted a gas of neon atoms with an attosecond UV pulse followed by an intense femtosecond red pulse. The attosecond pulse ripped off an inner electron and excited a second electron to the atom's periphery. Then the red pulse, consisting of just a few wave cycles with precisely controlled phase, could free the outlying electron by lowering the confining potential. When the three most intense peaks at the center of the red pulse coursed through the atoms, the tunneling probability neared 100%, and the electrons escaped in three steps. Each step took less than 400 attoseconds. (M. Uiberacker et al., *Nature* **446**, 627, 2007.) —BPS

Plasmon-assisted solar cells. Because of its ubiquity in electronics, silicon is the favorite semiconductor used in solar photovoltaic cells. But Si is a poor light emitter and absorber, and the efficiency of thin-film Si PV cells is even poorer than that of wafer-based thick cells. An important goal is to make the cells inexpensive by using thin films, but also to make them nicely absorptive. Scientists at the University of New South Wales in Australia have now enhanced the absorption of sunlight using surface plasmons generated on silver nanoparticles deposited on PV cells. SPs are collective oscillations of conduction electrons that can arise when light impinges on a metal particle whose size is on the order of the light's wavelength. Strong scattering occurs, and the SPs couple to the waveguide modes of Si; the light is effectively trapped. The researchers used this phenomenon in a PV solar cell to increase the cell's absorption efficiency. To create the particles, they deposited thicknesses of silver that ranged from 10 nm to more than 20 nm; during annealing, the silver coalesced into islands larger than 100 nm across. For 1.25-μm thin-film PV cells the group found a 16-fold absorption enhancement for light at 1050 nm, where Si normally absorbs poorly, and a 33% increase across all wavelengths of light (see the figure). For 300-μm-thick wafer PV cells, plasmon trapping increased full-spectrum absorption by 19%. According to Supriya Pillai, optimizing the nanoparticle size should bring additional improvements. The scientists also used plasmons to increase emission from thin-film LEDs. (S. Pillai et al., *J. Appl. Phys.* **101**, 093105, 2007.) —PFS



Magnetic resonance force microscopy has reached 90-nm resolution. MRFM maps the spins in a sample that is mounted on an ultrasensitive silicon cantilever hanging vertically over a sharp magnetic tip. If the tip's magnetic field is highly inhomogeneous, an applied radio-frequency field will resonate with the spins in a highly localized region of the sample, and the cantilever will deflect due to the resulting forces. To achieve the nanoscale resolution, John Mamin, Dan Rugar, and their colleagues at the IBM Almaden Research Center in San Jose, California, made tips with magnetic gradients of more than a million teslas per meter and held the samples about 45 nm away. The test objects being imaged consisted of tiny islands of calcium fluoride evaporated