localized coagulation, dehydration, and ablation. The fiber-optic laser technology used during this procedure can develop up to tens of watts of radiation at power densities up to tens of watts per square millimeter. In order to consider other light sources as alternatives to surgical lasers, the light sources should be able to concentrate radiation to these levels. With this requirement in mind, a group or researchers from the Ben-Gurion University of the Negev in Israel turned to sunlight. Solar radiation provides an inexpensive option with the potential for building small devices, and it performs as well as the surgical lasers, as the investigators demonstrate in their article in the September 30 issue of *Applied Physics Letters*.

D. Feuermann, J.M. Gordon, and M. Huleihil built a prototype from commercial materials based on a parabolic dish, which collected the solar radiation and supplied it through an optical fiber 1 mm in diameter. The maximum power supplied was 8 W, giving a flux concentration in excess of 11,000. Operating at similar levels to those used in studies for surgical lasers (about 5 W), the researchers conducted experiments in fresh chicken breast tissue. The contact exposures affected a small, well-defined area that coagulated and later ablated, and the plume of water vapor observed indicated the tissue dehydration that usually appears after coagulation. Bubbling and rupture of tissue was later observed, as well as posterior carbonization and ablation, consistent with the stages of traditional laser surgery. After several exposures positioning the fiber tip at different heights from the tissue, different carbonization rates were obtained: 0.2 mm/s at a height of 2 mm, 0.3 mm/s at a height of 1 mm, and 0.5 mm/s when making direct contact with the tissue. Experiments at similar conditions of power density using lasers with wavelengths of 515 nm and 1064 nm gave carbonization rates of 1 mm/s and 0.1 mm/s, respectively, when making direct contact with the tissue. Since the spectrum of sunlight includes wavelengths between 350 nm and 2200 nm, one might expect an intermediate carbonization rate when using solar radiation at the aforementioned conditions, as was observed in this study.

Applications of solar radiation for surgical procedures are limited to those requiring wide-angle emissions, therefore precluding those procedures requiring collimated light like retinal surgery. Future studies include quantification of the rates of tissue transformation and comparisons with laser surgical experiments.

SIARI S. SOSA

STM Indicates CuO_2 Can Form Stable, Atomically Ordered Layer at the Surface of $Bi_2Sr_2CaCu_2O_{8+\delta}$

Researchers at the University of Illinois at Urbana-Champaign have demonstrated that a single copper oxide plane can form a stable layer at a cuprate superconductor's ($Bi_2Sr_2CaCu_2O_{8+\delta}$) surface. This plane behaves differently when exposed at the surface than when buried inside the crystal, the researchers discovered, offering insight into the behavior of high-temperature superconductors.

As reported in the August 19 issue of *Physical Review Letters*, physics professor Ali Yazdani, graduate student Shashank Misra, and colleagues used a scanning tunneling microscope (STM) to image the copper oxide plane. The $Bi_2Sr_2CaCu_2O_{8+\delta}$ sample was cleaved in vacuum, exposing a mostly BiO-terminated surface. How-

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ever, other crystallographic surface planes are also observed. Atomic-level imaging and spectroscopy of those planes allowed the researchers to identify a surface CuO_2 plane.

"In contrast to previous studies, we found that this copper oxide layer exhibits an unusual suppression of tunneling conductance at low energies," Yazdani said. "We think the orbital symmetry of the plane's electronic states may be influencing the tunneling process and is responsible for the strange behavior we observed at the surface."

Surface-sensitive techniques, such as electron tunneling and photoemission, have been crucial in gleaning information about high-temperature superconductors, Yazdani said. But it has not always been clear from which layer the information was coming. By imaging at the atomic scale and probing on the nanoscale, the researchers achieved much higher precision.

"High-temperature superconductors are layered compounds containing one or more copper oxide planes and other layers that act as charge reservoirs," Yazdani said. "Like dopants in a semiconductor, these layers donate charge carriers to the copper oxide planes, making them conducting. The strong electronic interactions in the copper oxide planes are responsible for the material's unusual electronic properties."

By exploring large areas of the sample and correlating the STM topographic images with x-ray crystallographic data, the researchers were able to identify individual layers of copper oxide and of bismuth oxide and then measure their electronic properties.

"With the STM, we can send electrons through the tip and measure the rate at which they flow into the surface," Yazdani said. "We found a very strong contrast in the spectra taken on the two surfaces. The electron tunneling in the copper oxide plane was strongly suppressed at low energies."

This behavior is unexpected in a *d*-wave superconductor, Yazdani said, and could demonstrate the dramatic influence of the layered structure on the surface electronic properties. The observations can best be explained by the way in which the STM tip couples to the electronic states of the copper oxide plane, the researchers concluded.

"At low energies, electrons from the tip are constrained by the orbital symmetry of the plane's electronic-wave function, which resembles a cloverleaf pattern," Yazdani said. "This directional dependence of the current can explain the suppressed tunneling."

Neutron-Scattering Technique Developed to Characterize Nanoporous Thin Films

Researchers from the National Institute of Standards and Technology (NIST) reported on August 20 at the American Chemical Society meeting in Boston that they have developed methods for characterizing key structural features of porous films under consideration as insulators for the ultrathin metal wires in integrated circuits. The advance will help semiconductor manufacturers and their materials suppliers identify the most promising "nanoporous film" candidates for shielding miles of interconnecting wire on next-generation microprocessors.

To increase processor speed, semiconductor manufacturers seek to reduce chip sizes. However, size reduction introduces problems with electrical interference between circuit elements (crosstalk), motivating the development of better insulating materials. Current insulating materials such as silicon dioxide and fluorinated silicate glass (FSG) are approaching their limits as devices are squeezed closer together on a chip.

To prepare better insulating films, many materials suppliers are developing films

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