unhindered trade of GMOs.

Biotech opponents read the results differently. "The U.S. lost on most major issues," counters Philip L. Bereano of The Council for Responsible Genetics in Cambridge, Massachusetts. The Miami group drafted wording that would have allowed the WTO to overrule the biosafety treaty, he says; putting the two agreements on equal footing is seen as a victory by GMO opponents. And Bereano says it is a vindication that the environmentalists' darling, the precautionary principle, is written into the agreement.

The treaty puts off for 2 years the issue that kept the U.S. and E.U. at each other's throats until early morning in Montreal: whether to include the trade of GMOs that are not likely to propagate in the environment. The treaty states that such "commodity" GMOs intended for food or feed must be labeled "may contain" GMOs. But it does not require exporters to segregate GMO-containing products from traditional products. Some countries and companies already refuse GMO products and pay a premium for nonmodified crops—a market process that is likely to continue until the parties meet again in 2002. –LAURA HELMUTH

MATERIALS SCIENCE

Stretching Horizons For Electrical Devices

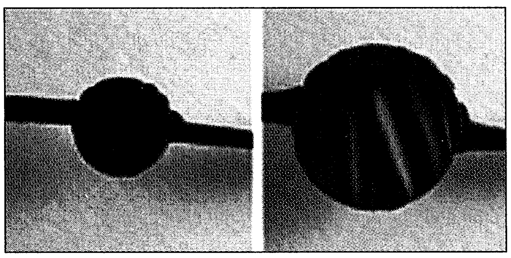
Hunting for materials that change shape when zapped electrically, researchers have found a new champion literally hanging out in the kitchen. A rubbery acrylic used to stick widgets to refrigerators triples its length when squeezed with high voltage. Known as a dielectric elastomer, the stuff has shattered the standard for electrically induced elongation, researchers report on page 836. The acrylic and its stretchy silicone brethren might someday control video displays, animate small robots, or power artificial limbs.

Ron Pelrine and his colleagues at SRI International in Menlo Park, California, achieved the record-breaking stretches while searching for better materials for electrical actuators, devices that turn electrical energy into mechanical work. Magnet-and-coil actuators drive stereo speakers, car door locks, and many other familiar electric contraptions. But smaller, higher tech actuators, such as those that guide the tip of a scanning tunneling microscope, rely on materials that deform when stimulated electrically. Substances that perform this trick include piezoelectric crystals, electrostrictive polymers, magnetostrictive alloys, and carbon nanotubes. The measure of motion for such materials is linear strain, the change in length divided by the initial length. The previous best was 41%; the SRI group hiked the figure up to 215%. "I was very excited by these results," says Ray Baughman, a materials scientist with Honeywell International in Morristown, New Jersey. "The strains you get here are just giant."

Pelrine's team fashioned parallel-plate capacitors from films of the elastomers by mounting each film on a rigid frame and painting electrodes of conductive grease on either side. They charged each capacitor to several kilovolts and flattened the material in the middle with an electrical double-whammy known as Maxwell stress. Opposite charges on the two sides of the film attracted each other and squished it like a hamburger between a spatula and a frying pan. Meanwhile, like charges along each surface of the film repelled each other, forcing it to stretch even more. With this technique alone, the researchers set the old record with a silicone elastomer.

To get even bigger strains, Pelrine and colleagues employed a new twist: stretching the film before they applied the voltage. The prestraining toughened the film so the researchers could apply higher voltages. It also stiffened the film in one direction so that energy from the electrical squeeze was funneled into straining the material in a perpendicular direction. The extra boost enabled Pelrine and colleagues to obtain strains of 117% for a silicone elastomer and 215% for the acrylic.

Some researchers aren't bowled over by the numbers. "How does this advance the science of the field?" asks Qiming Zhang, a materials scientist at Pennsylvania State University, University Park. The physics behind Maxwell stress is well understood, Zhang says; the interesting question is what underlying mechanism distinguishes the newfound elastomers from other stretchy substances.



CREDIT: R. PELRINE/SRI INTERNATIONAL

Spreadsheet. A circular capacitor on an elastomer film stretches wide when high voltage is applied.

Pelrine says the SRI team focused on finding promising materials. "Basically, we've tried everything we can try," he says. Indeed, he came across the star acrylic while sticking a plastic safety latch to his refrigerator door and decided to test it. Identifying materials with exotic properties is scientifically worthwhile, Pelrine says, especially if it leads to deeper study. He points to the discovery of high-temperature superconductors, in which huge improvements on the performance of conventional superconductors led researchers to new physical principles. "The jump in performance using the acrylic elastomer, for example, is so large," he says, "it begs the question of why it is so much better than other elastomers."

As for applications, dielectric elastomers provide 100 times more motion but roughly 1/30th as much pressure as piezoelectric crystals. They may therefore prove useful for tasks that require long movements but less pushing or pulling, such as covering and uncovering pixels on video displays or moving the limbs of small robots. Because the materials stretch farther and generate more pressure than living muscle, they may be useful for powering prosthetic limbs. Elastomers currently require high voltages, however, which may limit how they can be employed. "No one actuator technology is going to solve all the problems," Baughman says.

–ADRIAN CHO

CANCER RESEARCH

A Face-Off Over Tumor Blood Supply

Last September, cancer biologist Mary Hendrix of the University of Iowa, Iowa City, and her colleagues published a paper in *The American Journal of Pathology* that stirred up a hornet's nest in cancer research. It suggested that in very aggressive melanomas of the eye, blood-conducting channels that nourish the growing tumor are formed not by the endothelial cells of true blood vessels but by the cancer cells themselves (*Science*, 3 September 1999, p. 1475).

If correct, the finding could have major implications for efforts to find new cancer drugs. Currently, drug developers are working furiously to find compounds that inhibit the growth of the new blood vessels around cancer cells. Those drugs are aimed at endothelial cells, however, so they may not work against tumors that use an alternative means to get blood.

But the work touched off a critical backlash. Some blood vessel specialists and others maintain that the structures the Iowa team described could not be blood-conducting channels. Some of their concerns are presented in a commentary published in the February issue of *The American Journal of Pathology*. That's unlikely to resolve the issue, however, as Hendrix and her colleagues are sticking to their guns. So time has also been set aside for both sides to thrash out their arguments at a Keystone meeting on angiogenesis in Salt Lake City in early March.

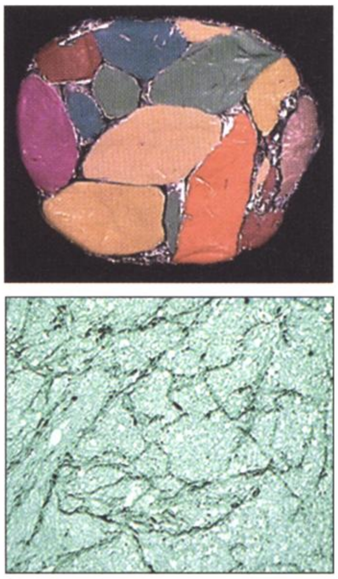
Pathologist Robert Folberg, a member of the Iowa team and now chair of pathology at the University of Illinois, Chicago, came to the conclusion that very aggressive eye melanomas have unusual blood channels after discovering distinctive looping patterns in slices of the tumors stained with a method called PAS that highlights extracellular matrix. Folberg also noted red blood cells apparently moving through channels formed by the matrix. When he then compared angiograms—pictures of the tumor blood vessels taken after a fluorescent dye had been injected into the patients' bloodstreams—with the PAS staining patterns of slices taken after those same tumors were removed, he saw similar looping patterns in both for the most aggressive tumors. That suggested, Folberg says, that the PAS-stained structures were conducting blood and represented a previously unknown type of blood channel that showed no signs of endothelial cells.

Blood vessel researcher Donald McDonald of the University of California, San Francisco, who co-authored the *American Journal of Pathology* commentary with Lance Munn and Rakesh Jain, both of Harvard, says he doesn't question the conclusion that tumors showing the looping patterns are particularly aggressive and deadly. That is "well documented," he says, but "I just don't buy" the team's assertion that the looping structures are blood-carrying channels.

McDonald, Munn, and Jain point out that the blood vessels of a tumor are a snarl of tubes, like a plate of hollow spaghetti. An angiogram of that plate would indeed show the noodles looping around in three dimensions. But if you were to slice the spaghetti crosswise as you would a tissue, says Jain, "you would see mostly cross sections of spaghetti," little circles or ellipses—not the looping strands. So, he and his colleagues conclude, the loopy structures that show up in the PAS-stained cross sections can't be the blood vessels seen in the angiogram. The red blood cells Folberg saw in the putative channels most likely leaked from ordinary tumor vessels, say the authors of the commentary.

Folberg counters that McDonald and Jain are mistakenly "assuming these things are conventional blood vessels," which, he says, they are not. The PAS-stained structures are sheets of extracellular matrix wrapped around masses of tumor cells, he says. To illustrate how they could form blood-conducting channels, Hendrix team member Andrew Maniotis resorted to a low-tech demonstration: He used spheres and cylinders of clay to represent masses of tumor cells and surrounded them with aluminum foil to represent the extracellular matrix.

When he pressed the clay blobs together tightly, as the cell masses would be within a tumor, in most spots, the aluminum foil covering adjacent blobs was in such close contact that no liquid could flow between them. But in some places, because of the curvature of the clay, there were openings that formed ribbonlike channels where liquid could flow. These, the team proposes, represent the blood channels that show up in the angiogram—loopy in shape because they follow the contours of the blobs. In addition, when Maniotis sliced through the clay mass and looked at the pattern made by the aluminum foil, he saw a pattern of back-to-back loops, similar to the PAS-stained pattern. The team recently took another form of the model, made from sausage skins bathed in contrast dye and stuffed with wax, and did a computerized tomography (CT) scan to trace the three-dimensional pattern of the dye in the channels. The CT scan images "look very similar to the angiograms," says Hendrix.



Claymation. The aluminum foil wrapped around clay in this model of tumor tissue (*top*) resembles the loopy patterns seen in a stained section of a real tumor (*bottom*).

CREDITS: (TOP TO BOTTOM) MANIOTIS *ET AL., AM. J. PATHOL.* 155(3), 739 (1999); A. MANIOTIS, DEPARTMENT OF ANATOMY AND CELL BIOLOGY/THE UNIVERSITY OF IOWA

Even if the skeptics accept that the clay and sausage-casing models show that such channels can exist in tumors, they say that Hendrix's group will need to do more to show that blood actually flows in the channels. And even if the channels do conduct blood, some question whether the blood flow would have much impact on tumor growth. Blood vessel researcher Adrian Harris of the University of Oxford in the United Kingdom notes that his team, as well as many others, has found that the same type of melanoma studied by the Hendrix group is full of conventional blood vessels. In that case, says tumor biologist Robert Kerbel of the University of Toronto, Ontario, any blood flowing in those channels "could be a very minor percentage of the total [tumor blood flow]."

Nelson Fausto, editor of the pathology journal, says he deliberately did not show the McDonald commentary to the Hendrix group for their comment because he wanted to let McDonald, Munn, and Jain have their say. But Hendrix will have an opportunity to present her team's models for scrutiny in a debate with McDonald scheduled for the Keystone angiogenesis meeting. Ultimately, however, the Hendrix team's hypothesis is more likely to stand or fall on the results of experiments in animals to nail down the contribution, if any, of the mysterious channels to tumor blood flow.

–**MARCIA BARINAGA**

U.S. PRIZES

17 Get Science, Technology Medals

Researchers who plumbed the depths of the Antarctic ozone hole, helped show that modern cells are assembled from once-independent life-forms, and created reading machines for the blind were among those awarded National Medals of Science and Technology this week by President Bill Clinton. They will be honored at a 14 March ceremony.

A dozen investigators won the coveted National Medal of Science, which Congress created in 1959, while four investigators and one company gained the prestigious National Medal of Technology, created in 1980. Cellular biologist Lynn Margulis of the University of Massachusetts, Amherst, one of two women honored, helped win acceptance for the once-controversial idea that plant and animal cells are the product of partnerships between ancient, bacterialike organisms. Atmospheric researcher Susan Solomon of the National Oceanic and Atmospheric Administration, an unusually young medalist at 44, was honored for her studies of the South Polar ozone hole. Raymond Kurzweil, founder of Kurzweil Technologies, was recognized for his pioneering work on voice recognition, which has produced many modern aids for the visually impaired.

The other science winners, by field, are: Biology—David Baltimore, California Institute of Technology; and Jared Diamond, University of California, Los Angeles. Chemistry—Stuart A. Rice, The University of Chicago (UC); and John Ross, Stanford University. Economics—Robert M. Solow, Massachusetts Institute of Technology (MIT). Engineering—Kenneth N. Stevens, MIT. Mathematics—Felix E. Browder, Rutgers University; and Ronald R. Coifman, Yale University. Physical Sciences—James W. Cronin and Leo P. Kadanoff, UC.

Other National Medal of Technology winners are: computing innovator Glen Culler, Culler Scientific Systems; biotech industry pioneer Robert Swanson (deceased); ARPAnet founding father Robert Taylor (retired); and Symbol Technologies Inc., for development of laser bar code scanning and wireless local area network technologies.

–**DAVID MALAKOFF**