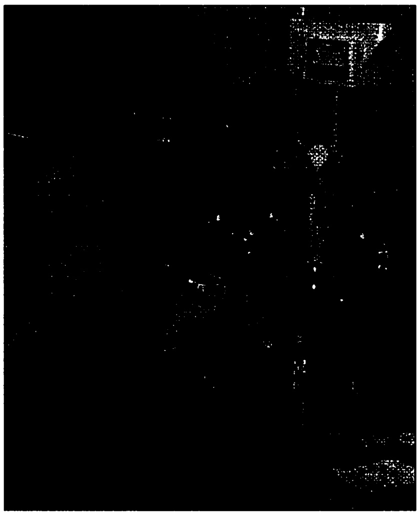
JAPAN

Blue Laser Pioneer Seeks Greener Pastures

Shuji Nakamura is something of a national hero in Japan. The 45-year-old materials scientist's pioneering work on blue light–emitting diodes (LEDs) has been held up as an example of how Japanese researchers can outperform their colleagues in the United States and Europe, and it has paid off handsomely for his employer, a small Japanese chemical company. But when Nakamura decided to leave industry for academia, he says his destination was a no-brainer: the United States. "Even if you produce some superb invention, your salary and position don't improve [in Japan]," he says.

Nakamura's arrival this month at the University of California, Santa Barbara (UCSB), will strengthen its already strong program in compound semiconductor materials. He also hopes it will send a message to his native country to rethink its veneration for seniority and credentials over objective measures of performance. Combined with a stifling bureaucracy, the rigid academic hierarchy prevents scientific stars from shining as brightly as they might elsewhere. "It's a very silly salary system," fixed by law and based strictly on seniority, says Leo Esaki, a physics Nobelist and former president of the University of Tsukuba. Other regulations make hiring technicians and assistants nearly impossible, and collaborations with the private sector are also restricted. In contrast, says Nakamura, "American university professors have a lot of freedom."



California dreaming. Nakamura has left Nichia for UC Santa Barbara.

Nakamura stunned the optoelectronics world several years ago when he beat out dozens of well-funded academic labs and such industrial heavyweights as Sony and Hewlett-Packard to the development of blue LEDs and, later, blue semiconductor lasers (*Science*, 21 March 1997, p. 1734). The shorter wavelengths allow for a fourfold increase in the storage capacity of CD players and CD-ROM drives over current equipment, which uses infrared lasers to read the digital signals. In addition, blue LEDs join previously developed red and green LEDs to complete the palette of primary colors, enabling long-lasting, energy-efficient LEDs to dominate such niche applications as sports stadium displays. And white LEDs, which combine red, blue, and green LED structures in one device, could eventually make conventional light bulbs obsolete.

Nakamura's success was based on new fabrication methods for gallium nitride, a material most researchers felt was too difficult to handle. His employer, Nichia Chemical Industries, announced its creation of the blue LED in 1993 and started shipping samples of its blue semiconductor lasers early last year. Thanks largely to Nakamura's research, Nichia's sales have more than doubled in 4 years, to $390 million in 1998.

With the blue laser now headed for production, Nakamura says he was looking for new challenges. And although he won't criticize his former employer, he admits that he wasn't entirely happy with his position or his compensation. The move dispelled those clouds. His Santa Barbara salary will be "above-scale," he says, and he has received a $3 million package to set up his laboratory.

"Researchers like Nakamura have an international market value," says Esaki, who 40 years ago left another tiny Japanese company—which later became Sony Corp.—for the greater research support and better pay of IBM's T. J. Watson Research Center in Yorktown Heights, New York, before returning to Japan in 1992. "And Japan has to recognize this if it wants to attract and keep such people." A Nichia spokesperson declined to comment on Nakamura's pending departure, and Matthew Tirrell, dean of UCSB's College of Engineering and a professor in the materials science department, says simply that "we are delighted to have Shuji Nakamura join us."

Even as Nakamura levels his broadside, Japan may be missing an opportunity to improve the academic environment for talented researchers. It is planning to turn the national universities into semi-independent entities, but a spokesperson for the Ministry of Education, Science, Sports, and Culture (Monbusho) says the ministry is leaning toward preserving the status of faculty as national civil servants, subject to all current laws and restrictions. "Most faculty want to continue as national employees because of the employment security," says the spokesperson, although he notes that a final decision has not yet been made.

Nakamura believes that such a decision will encourage even more potential or current academics to head overseas. And that exodus, he says, "should say to the Japanese government that current conditions are not very attractive."

–DENNIS NORMILE

BIOTECHNOLOGY

Both Sides Claim Victory in Trade Pact

After 5 years of bitter negotiations, delegates from 130 countries finally hammered out a global treaty that will govern the trade of genetically modified organisms (GMOs). The treaty formalizes the process by which countries can refuse to accept biotech products, an apparent blow to the biotech industry. Even so, both proponents and critics of biotechnology came away from the negotiating table at 5:00 a.m. in Montreal on 29 January claiming victory.

One reason for the unexpected compromise may be that the wording of the new treaty is decidedly ambiguous. For instance, the treaty allows countries to refuse to import GMOs based on a "precautionary principle"—that is, even without "sufficient scientific evidence" that the products could cause environmental harm or threaten human health. Elsewhere, however, the treaty stipulates that such rejections be based on "credible" scientific evidence.

The treaty focuses on living modified organisms such as seeds and fish that can colonize an ecosystem. It calls for the creation of a clearinghouse for information about such GMOs. Exporters will be required to register new products with the database, which will be run by the United Nations, and provide scientific information about how they were created and tested. Exporters must also seek permission from importing countries to ship the new products the first time.

At issue is the safety of GMOs, a topic that has pitted the United States, Canada, and a few other agriculture-exporting countries against the GMO-wary European Union (E.U.) and most developing countries. Asserting that GMOs are safe and a valuable tool for agriculture, the U.S.-dominated team, known as the Miami group, agitated for relatively unrestricted trade in GMOs.

"The Miami group got virtually everything it wanted," asserts Val Giddings of the Biotechnology Industry Organization in Washington, D.C. Giddings points out, for example, that the treaty excludes pharmaceuticals, in which the United States has a major stake, and it will not supercede trade agreements under the World Trade Organization (WTO), which encourages relatively

CREDIT: D. NORMILE

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

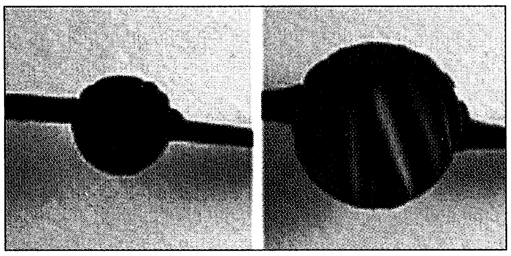
Hunting for materials that change shape when zapped electrically, researchers have found a new champion literally hanging out in the kitchen. A rubbery acrylic used to stick widgets to refrigerators triples its length when squeezed with high voltage. Known as a dielectric elastomer, the stuff has shattered 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