Among those likely to benefit are researchers studying the northern slope of Alaska. That area sits on a political fault line, as it is home to both the Arctic National Wildlife Refuge and reserves of oil and gas. USGS scientists have spent years gathering seismic, geochemical, and other data of use to policy-makers weighing the future development of the region, but in recent years the data collected have been meager. Sending teams by helicopter into the remote, roadless region "costs tens of thousands of dollars a day," says Thomas Fouch, chief geologist for the division's central region.

In other instances, marine researchers will be able to afford to lease their own ships instead of sharing time on other agencies' vessels, and geological mappers will no longer have to pay field costs out of their own pockets. A survey of the nation's coal reserves, once done every 5 years, can be conducted for the first time in 2 decades.

In spite of these benefits, several staffers told *Science* that they question whether it was necessary to cut so many positions, or to do so in one blow. They point out that the cutbacks were based on a projected 20% cut next year in the Geologic Division's current appropriation of $213 million, but this summer the House gave it $208 million and the Senate, $211 million. (The difference will be ironed out when Congress reconvenes next month.) Cannon says, however, that the reorganization was needed to halt the erosion in the research budget over many years.

Even so, some worry about how the changes will affect both basic research and the response to floods and earthquakes. On top of the layoffs, buyouts over the last 2 years cut 400 jobs at the Geologic Division, including many senior scientists. Their shoes will be hard to fill, say colleagues. "A lot of what these people knew they walked around with in their heads," says a senior researcher in the Menlo Park office. "It's just not certain how that's going to play out."

–Jocelyn Kaiser

CHEMISTRY

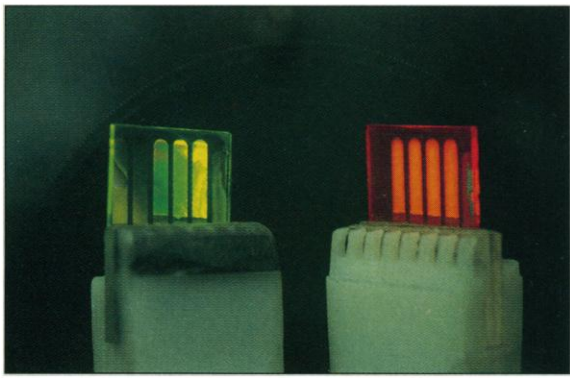
Polymer Light-Emitters Gain New Life

Roll-up television screens, luminescent wallpaper, and cheap, brilliant displays for everything from cellular phones to microwave ovens—those are just a few of the benefits that polymer-based light-emitters seemed to promise when they were developed 5 years ago. But this promise has since dimmed with the discovery that light-emitting diodes, or LEDs, made of polymers have a shelf life of just months and often an even shorter working life. On page 1086 of this issue, however, a team of researchers from UNIAX Corp. in Santa Barbara, California, reports a new design for a polymer light-emitter that may give the technology some life support.

The design addresses two roots of polymer LEDs' lifetime problem: the need to load the polymers with electric charges through electrodes made with highly reactive metals, which degrade quickly, and the need for high voltages to operate some LEDs, which can heat the devices and damage the polymers and electrode materials. The team, working with UNIAX polymer researcher Floyd Klavetter, came up with a single solution: a new type of light-emitter, called a light-emitting electrochemical cell (LEC), that is much easier to load with charges, thereby doing away with the need for both the unstable electrodes and the high voltage.

"It's a radical new innovation with great promise," says Olle Inganäs, a physicist and polymer LED specialist at the University of Linköping in Sweden. "You input less energy into the devices, and the energy comes out as light instead of heat," which should lengthen the working lifetime. The new light-emitter also has a dramatically longer shelf life, the UNIAX group reports—already 1 year and counting. But Inganäs and others point out that LECs don't solve all of the problems that stand between polymer light-emitters and the market, because the specialized polymers at the heart of these devices tend to break down even under the best circumstances.

The UNIAX team built on the basic LED design, which sandwiches a semiconducting polymer between two electrodes. When a voltage is applied across the electrodes, it creates an electric field that pulls low-energy electrons from polymer molecules near the positively charged electrode, or anode, forming electron vacancies, or "holes." Meanwhile, the opposite electrode, or cathode, adds high-energy electrons to the adjacent polymer molecules. These holes and excess electrons migrate through the conducting polymer. When they meet at the center of the device, the energetic electrons can drop into the holes, giving up their excess energy as light.



UNIAX CORP.

Lasting shine. The addition of mobile ions extends the shelf life of these polymer light-emitters.

But setting these charges in motion in the first place can be difficult. The polymers' poor conductivity means they don't easily accept electrons, and so it can take high voltage to drive negative charges into them. To improve the electron transfer, researchers make the cathodes from calcium or some other reactive metal that is especially eager to give up electrons. But oxygen degrades such materials, so they must be sealed from exposure to air, which would boost the cost of making a commercial device. And because such seals often leak, in the long run these cathodes still end up degrading.

To get around the problem, the UNIAX researchers—Qibing Pei, Gang Yu, Chi Zhang, Yang Yang, and Alan Heeger—added charged ions that temporarily boost the conductivity of the polymers when the power is on. As in a battery or any other electrochemical cell, the ions—in one case, positively charged lithium ions and negatively charged trifluoromethanesulfonate, or triflate, ions—are free to migrate through the polymer, because the mixture also includes a solvent. That mobility enables the ions to act as chaperones for incoming charges.

When a device containing a polymer-ion blend is switched on, the charged polymers created near the anode and cathode attract ions of opposite charge. There, ions pair up with polymer molecules, stabilizing these charges. That prevents the charges from moving off these polymers into the center of the device, a change that improves the conductivity of the molecules. As a result, additional charges can flow more readily from the electrodes into the device—and the extreme measures needed to pump charge into earlier devices can be dispensed with.

Using stable metal cathodes made from aluminum or gold, the UNIAX researchers have built LECs that emit orange, green, and blue light, depending on the polymer—and do so at voltages as low as or lower than those of LEDs that use reactive electrodes. After sitting on a shelf unused for a year, test devices still worked normally, the group found. Now the researchers are trying to determine how long the devices last when operating. If they can shine on for thousands of hours, a number comparable to today's best polymer LEDs, they may finally help polymers shine on the market as well.

–Robert F. Service