

Goodbye, bifocals?

An ultrathin liquid crystal layer sandwiched between layers of glass could render bifocals obsolete, say optical scientists at the University of Arizona and Georgia Institute of Technology in a recent paper in the *Proceedings of the National Academy of Sciences*.

"When we are young, we can look at objects at different distances—we can read, look at the computer, or drive—and our eyes compensate and focus everything to the retina," says Arizona's Nasser Peyghambarian. With age, the eye muscles get stiff and lose some of their responsiveness, leading many people to need eyeglasses. Nematic liquid crystals could adjust for focal length and thus correct for both near- and farsightedness, as well as for other aberrations in vision, he says.

In liquid crystals, the refractive index, which determines by how much light is bent, changes with applied voltage. The trick is to program a microelectronics chip to control the applied-voltage pattern to correspond to the accommodation needed by the wearer. The chip could be reprogrammed to adjust for changes in eyesight, so that one pair of liquid crystal eyeglasses could last a lifetime.

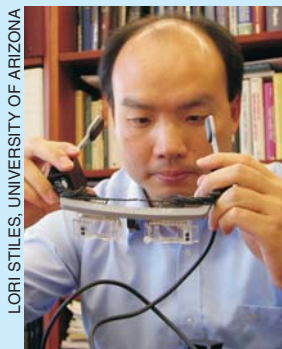
In the prototype glasses, a 5- μm layer of liquid crystal is sandwiched between transparent electrodes deposited on glass slabs 0.5 mm thick. Voltages of 2 V or less are applied, with changes in the index of refraction occurring in fractions of a second. The eye-

glass wearer would not notice any focusing delay, Peyghambarian says.

"Vision correction has stringent requirements, such as large aperture, fast response time, high light efficiency, low operation voltages, and power-failure-safe configuration," says Arizona's Guoqiang Li. The team's prototype with liquid crystals is the first such effort "that is practical for vision correction," he adds.

In the prototype, the applied voltage comes via a bulky chip that is switched on and off manually, but eventually, says Peyghambarian, the glasses "would be adapted with a range-finder mechanism, so that things at different distances would automatically come into focus, like with an autofocus camera lens." A Virginia company is exploring commercializing the glasses.

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Cacti as seen by a model eye with (right) and without correction from an activated liquid crystal lens. Researcher Guoqiang Li (above) models prototype liquid crystal eyeglasses. (Cactus images courtesy of G. Li et al., *Proc. Natl. Acad. Sci. USA* **103**, 6100 (2006), © 2006 National Academy of Sciences.)

some 26 years ago in hopes of developing more efficient light sources.

"The conventional incandescent bulb lamp and fluorescent lamp are technology-based vacuum-tube lighting. LEDs and laser diodes could replace [them] as the semiconductor-based transistor replaced the vacuum-tube-type circuit in the past," Nakamura said. LEDs convert electrical energy to bright light with 50% efficiency, he pointed out, a rate 10 times better than that of an incandescent bulb. Moreover, he added, the life span of an LED is "almost forever," meaning it requires virtually no maintenance.

Although LEDs had already been discovered by the time Nakamura began researching them, no one had yet determined how to make blue LEDs. According to Steven DenBaars, also a professor of materials at UCSB and the other codirector of its solid-state lighting and display center, discovering how

to make blue LEDs was important because it increased the available palette of colors, which in turn increased the potential number of applications for the technology.

"You can't paint with just red and green. Blue was the missing color," DenBaars explained. "Everybody was looking for the blue LED, trying to find it with zinc selenide. But that did not produce a bright blue light or a reliable blue light. You couldn't see it, so it wasn't useful for room lighting or illumination. It was not commercially viable."

Nakamura successfully used a gallium nitride-based material to develop the blue LED and laser diode. And the LED light required significantly less power to operate.

Once he successfully created the blue LED in 1993, it took just two more years to discover how to create a green LED, by adding indium to a blue LED. Before Nakamura's invention, the green in full-

color displays was a phosphorescent yellow. His technology gives the greens in large full-panel LED displays a far richer hue, the prize foundation said.

In 1996, Nakamura discovered how to convert the output of blue LEDs to make white LEDs. He said the efficiency of white LEDs is expected to approach 100% as they are more widely produced.

"Then, all of the conventional lighting, such as incandescent bulbs and fluorescent lamps, could be replaced with the white LEDs in order to save energy and resources," he said. "Also, the white LEDs could be operated by a battery powered by a solar cell in the daytime. So the lighting could be operated with clean energy thanks to its high efficiency and low voltage operation."

Nakamura believes that use of solid-state lighting in industrialized nations would save enormous amounts of energy. "In the US alone, using white