SCIENCE NEWS Online
THE WEEKLY NEWSMAGAZINE OF SCIENCE

Week of June 14, 2003; Vol. 163, No. 24

# Fixed Focus: Adjustable lenses from liquid droplets

Peter Weiss

Grinding glass is one way to make a lens. Using plastic goop, a little salt, and electricity is now another way. That's what researchers at Lucent Technologies' Bell Labs in Murray Hill, N.J., have done to create lenses the size of sesame seeds.

The lenses are even adjustable. The salt added to the goop, a liquid-polymer precursor, makes it electrically conductive, so the lenses' shapes can be adjusted by applying voltages. Once the droplet assumes the desired form, a few minutes under an ultraviolet lamp polymerizes the liquid into a hard lens.

These lenses may cut the price of the assemblies of laser chips and light-manipulating components in fiberoptic telecommunications systems, says chemist Shu Yang, a member of the Lucent team. Currently, installing such assemblies requires a technician to use an expensive micromanipulator to make time-consuming alignments of tiny, hard lenses. The droplet strategy may offer an easy-to-tweak alternative, Yang says.

To shape a lens before hardening it, the Lucent researchers start with a glass slide coated with a conductive film. After etching that film to form an electrode, they deposit a slick coating similar to Teflon and finally add a droplet of polymer precursor. The liquid beads up into a lens shape on the naturally repellent coating.

In the absence of a voltage, the droplet has as little contact with the coating as possible. This produces a rounded lens with a small focal length, so the drop can focus light only to a point near itself.

However, as a voltage is applied, electric charges accumulate beneath the droplet, creating an electric field that draws the droplet toward the coating. That downward tug flattens the droplet, increasing its focal length by up to 30 percent as the voltage is raised.

By applying a more complex pattern of voltages, which is possible because the electrode has several independent sectors, the researchers can also exert a sideways force on the liquid lens. Such a capability could prove useful for

aligning the lens with other miniaturized components, the team reports in the June 5 Advanced Materials.

Making the new type of lens is "a clever and imaginative step," comments John A. Rogers of the University of Illinois at UrbanaChampaign, who is on leave from Lucent. "The ability to tune these types of photocurable lenses and then lock them into place could reduce significantly the cost of many kinds of optoelectronic components."

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http://www.sciencenews.org/20030614/fob6.asp
From Science News, Vol. 163, No. 24, June 14, 2003, p. 373.