

▶ data storage. InPhase Technologies of Longmont, Colorado, does this using a series of holographic images, each of which is a grid of light and dark patches corresponding to 1s and 0s. These are stored on a disk that is read, one such grid at a time, by a laser. The disk is able to hold lots of data because each grid is made visible from a slightly different angle, just as a hologram of a solid object can be seen from different angles. InPhase recently launched its first commercial holographic drive, capable of storing 300 gigabytes on each disk, or the same as about 60 DVDs.

But the data stored on these disks cannot be changed or erased after being written. Fortunately, Nasser Peyghambarian of the University of Arizona, in Tucson, may have found a way around this problem. His photorefractive polymer, which he reported recently in *Nature*, stores images in an unusual way. Instead of (for example) converting silver halide into particles of metallic silver to form an image, the incoming laser beams change the distribution of electrons within the material. That, in turn, creates irregularities in its refractive properties, forming a diffraction pattern. A new pair of laser beams redistributes the electrons, creating a new hologram—and the process can carry on indefinitely.

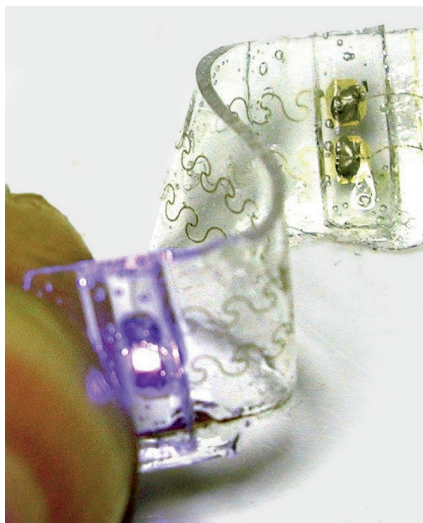
As well as creating rewritable holographic storage, this technique might also be able to generate moving holograms, provided the rewriting was fast enough to fool the eye. It is yet another possible path to 3-D television, which seems to be coming, one way or another. ■

The new shape of circuitry

Materials: Making circuits that are stretchable could open up a host of new applications, from medical sensors to video-game controllers

ELECTRONIC circuits that stretch like elastic bands or expand like balloons sound not just fanciful, but impractical. Yet a little flexibility could be useful, at least in some situations: for medical implants and sensors, for example. IMEC, a Belgian research group, has recently made a start on this idea by building tiny electric wires that can stretch to twice their length without breaking.

IMEC produced its stretchy wires by encapsulating tracks of gold that look like meandering rivers within an elastic silicone film. The arrangement works like a flat spring: when it is stretched, the spring opens up without the wires breaking.



Electronics go elastic

And just in case a break does happen, neighbouring tracks are arranged in sets of four, cross-connected at regular intervals, to ensure an unbroken connection.

These stretchy circuits can be built using standard techniques. To demonstrate the idea, IMEC has made a prototype of a stretchable digital watch. It still contains some rigid components, like solid islands within a sea of stretchy silicone material. Nevertheless Jan Vanfleteren, who is leading the project, hopes that future versions will be made fully flexible by using an ultra-thin chip-packaging technology that IMEC is developing.

This work is part of a collaborative project, called STELLA (Stretchable Electronics for Large Area Applications), which numbers Philips, a Dutch electronics giant, and Urgo, a French producer of sticking plasters and bandages, among its participants. But this is not the only group interested in the field.

Nokia, the world's largest mobile-phone maker, is working with Stéphanie Lacour, of the University of Cambridge's Nanoscience Centre, to develop a way to deposit gold films onto elastomers (elastic polymers), to make the films stretchy as well as bendable. Normally a gold film will fracture if stretched by as little as 1-2% of its original length. Dr Lacour's stretchy film, however, contains an array of tiny Y-shaped cracks. When it is pulled, the cracks open up and the film remains intact. It could thus provide a reliable way to wire up tiny silicon chips that could also be embedded in the elastomer.

Such "stretchable electronic skin", as Nokia dubs it, is initially intended for use in touch sensors. Tapani Ryhanen, Nokia's head of strategic research, suggests that stretchy sensors built into clothing could be used to measure emotional states. And an entire body suit made from flexible electronics and sensors could be the ultimate video-game controller. ■

A healing balm

Materials science: Self-healing substances that are capable of repairing themselves when damaged are under development

ONE of the differences between animals and machines is that animal bodies can repair a lot of the damage that a cruel and hostile world inflicts on them. A machine, by contrast, has to wait for someone to come and fix it. But that may change if researchers in the field of self-repairing materials have their way. Two groups in particular—one in America and one in Britain—are trying to create composite materials that mend themselves if they get cracked, in much the same way that an animal's broken bone heals itself. The difference is that these materials will heal in minutes rather than months.

Such self-healing composites may take a while to enter everyday use. But if they can be made reliably they will be welcome in high-stress applications that are difficult to inspect regularly (the blades of wind turbines, for example) or are critical to safety (such as the doors and window-frames of aircraft).

Jeffrey Moore and his colleagues at the University of Illinois are working on the problem by adding extra components to their composites. Like most such materials, these composites consist of fibres (in this instance, carbon fibres) embedded in a plastic matrix (an epoxy resin). The main extra component added by Dr Moore is a sprinkling of tiny capsules containing a chemical called dicyclopentadiene. If the composite cracks, the capsules near the crack break open and release the dicyclopentadiene molecules, which link together to form another type of plastic that binds the crack together and thus heals the material.

To start with, Dr Moore had to nurse this process along by adding a second extra component—a catalyst based on ruthenium. This worked well in the laboratory, but ruthenium is too expensive for mass deployment. However, when he was playing with solvents that might be added to the system to speed the transfer of the dicyclopentadiene to the cracks it is intended to heal, he found a solvent that encouraged the process to work without the ruthenium catalyst. Alas, the solvent Dr Moore hit on, chlorobenzene, is pretty nasty stuff (it is used, for example, in the manufacture of DDT). But he has since found a suitable alternative that turns out to be even better. The ▶▶