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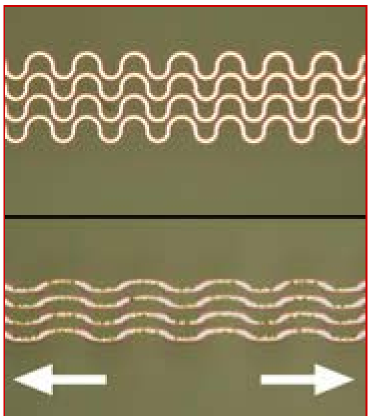
Stretchy wires form bendy circuits

Rubbery electronics might be possible using gold springs.
15 March 2004

PHILIP BALL



The wires can stretch to over half their original length.
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US researchers have made electronic circuits that can stretch like rubber. The flexible wires might create wearable electronics or artificial nerves that can bend inside the body.

Vigorous twisting and stretching destroys traditional electronics made from metals or silicon. And earlier versions of bendy electronics tended to break down if they were deformed too much.

Christopher Chen at Johns Hopkins University, Baltimore, and his co-workers built rubbery circuits out of several squashed but extendable gold wires. These are 20 times thinner than a human hair and wrapped in a springy polymer. The wires can be stretched by over half their initial length without loss of electrical conductivity.

Wiring like this could be woven into stretchy sports clothing and used to connect up sensors that monitor athletic performance. Rubbery electrodes made from biocompatible materials might be attached to a beating heart and used to sense impending problems.

Flexible electronics might also make rubbery needles, suggests Chen. These could be safer and more reliable than the needles currently used in the brains of Parkinson's disease patients, whose tremors are soothed by electrical stimulation.

There are lots of applications that can be imagined. "We joke about making electrical devices that you can throw against a

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wall: instead of breaking they would bounce back at you", says Chen. "But we have no idea if that is possible."

The usual way to make stretchable conductors is to embed metal particles in a rubbery polymer. But the particles tend to separate when the material is stretched, causing the electrical conductivity to plummet.

Straight wires normally break if stretched; but they do bend easily. Turning wire into a coiled and extendable metal spring exploits that property. Chen and colleagues decided to use this trick to make stretchy wires.

Instead of fashioning the gold wires into helical springs, however, they gave them a flat, oscillating shape, like a meandering river, since this is easier to make. They manufactured them by electroplating gold onto a sheet of silver, surrounding the wires with polymer and then stripping the silver away.

The researchers refined the wires to avoid buckling and breaking at the peaks of the bend. Thin wires break less easily than fat ones, they found, so the electrical current is carried in several parallel thin wires rather than one wide one. And small wiggles work better than broad ones.

Chen's group got their best results from a parallel series of thin, tight wiggles, which look rather like a slice through a stack of corrugated-iron sheets. If they are not stretched beyond breaking point, the researchers estimate that the wires should be able to withstand several thousand cycles of extension and contraction.

References

1. Gray, D. S., Tien, J. & Chen, C. S.. *Adv. Mater.*, **16,** 393 - 397, (2004).

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