



**NATIONALGEOGRAPHIC.COM**

[Site Index](#) | [Subscribe](#) | [Shop](#) | Search

Go



## NATIONAL GEOGRAPHIC NEWS

REPORTING OUR WORLD DAILY

[Top 15 Most Popular Stories](#)

### NEWS

[Front Page](#)  
[Photo in the News](#)

[Video in the News](#)

[Animals & Nature](#)

[Archaeology & Paleontology](#)

[Environment](#)

[History & Culture](#)

[Science & Space](#)

[Health](#)

[Offbeat](#)

[Travel & Adventure](#)

### SPECIAL SERIES

[The Genographic Project](#)

[Pulse of the Planet](#)

[National Geographic Channel](#)

### RESOURCES

[XML](#) [RSS](#)

[\(What's this?\)](#)

[Contact Us](#)

[Front Page](#) > [Science & Space](#)

## Flexible Electronics One Step Closer With New Circuits

**Ben Harder**  
for [National Geographic News](#)  
December 15, 2005

New silicon circuitry can bend and stretch like rubber, without losing its ability to function.

Flexible circuits could give electronic devices—including digital cameras, iPods, and TVs—a host of new and improved capabilities.

And manufacturers might someday be able to add electronics to the surfaces of devices that currently lack them (think heart monitors built into surgical gloves or artificial limbs with "skin" that can sense touch).

"These concepts are technically feasible," said electrical engineer Sigurd Wagner of Princeton University, who was not part of the research team. "But none of them is yet practical."

University of Illinois materials scientist John A. Rogers masterminded the innovation. "Silicon is intrinsically a brittle material, and you're not going to get around that," he said. "But you can come up with tricks to avoid that problem."

Engineers can already make electronics that flex without snapping, such as the superthin microprocessors in smart cards.

Smart cards are small plastic cards that store and process data and records. The most common examples in the United States are credit cards that house their microprocessors under small, square, gold contact pads.

"Smart cards have very small integrated circuits," Princeton's Wagner said. Each circuit "is so thin that when you sit on your wallet [the microprocessor] doesn't break."

The field's ultimate goal, experts say, is to make circuits that can conform to a curved surface or that can change shape as they function.

### Making Waves

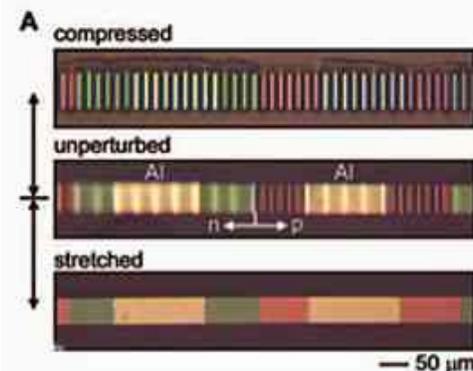
"Bendability and stretchability are different mechanical

### TODAY'S MOST POPULAR STORY



[Photo in the News: Oldest Known Maya Mural Reveals Royal Tale](#)

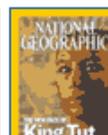
Advertisement



A flexible silicon circuit is shown compressed (top), at rest (middle), and stretched.

This new type of circuit continues to function even as it is bent and pulled. As such, it could pave the way to innovative products, including artificial skin with sensors that "feel," bouncing iPods, and TVs you can twist in knots.

Image courtesy *Science*



### Magazine Savings

Get one year of *National Geographic* for only \$15.

[SUBSCRIBE »](#)

characteristics," said Illinois's Rogers. For example, paper can bend but not stretch.

To create stretchable electronics, Rogers and his colleagues first made ribbons of silicon using a standard method.

**CONTINUED** [1](#) | [2](#) [Next >>](#)

#### MOST POPULAR STORIES



#### [Photo in the News: Oldest Known Maya Mural Reveals Royal Tale](#)

Archaeologists have revealed the final wall of the earliest known Maya mural, sa...



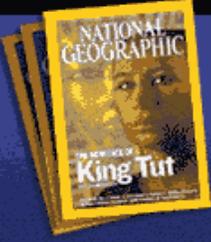
#### [Oldest Known Maya Mural, Tomb Reveal Story of Ancient King](#)

Archaeologists have revealed the final wall of the earliest known Maya mural, sa...



#### [King Kong Island Home Is Pure Fantasy, Ecology Experts Say](#)

Skull Island, the mythical home of the great ape King Kong, is supposed to lie i...



SPECIAL OFFER, SAVE 74%

Order National Geographic Magazine

U.S. PRICE IS ONLY

\$15

12 Monthly Issues

SEND NO MONEY NOW!

Fill in all fields.

Name

Address  City

State

Zip Code  E-mail

I would like to receive regular e-mail updates.



For Gift Orders,  
Click Here

For International Orders,  
Click Here

Offer applies to U.S. and Canadian addresses only. Savings based on annual U.S. newsstand price of \$59.40. Canadian price C\$20 (\$17 U.S.), including GST. Sales tax will be added where applicable. Allow 4-6 weeks for delivery. While all dues support National Geographic's mission of expanding geographic knowledge, 90 percent is designated for the magazine subscription, and no portion should be considered a charitable contribution.



#### RELATED STORIES

- [Spray-On Solar-Power Cells Are True Breakthrough](#)
- [New Backpack Generates Its Own Electricity](#)
- [Nano-Switches Could Yield Even Smaller Gadgets](#)

Search

#### RELATED WEB SITES

- [Science](#)
- [Takao Someya's Curriculum Vitae](#)
- [Department of Chemistry, University of Illinois](#)
- [Sigurd Wagner, Princeton University](#)

#### ARTICLE TOOLS

-  [E-mail This Story](#)
-  [Sign up for Newsletters](#)
-  [Reprints/Permissions](#)

#### SHOP NATIONAL GEOGRAPHIC



#### Inside 9/11 DVD Set

Go beyond what has been reported for a clearer picture of the day that redefined America.

**\$29.95** [SHOP OUR STORE »](#)

**Sponsored Links****[FPCsales.com - Flexible Circuits](#)**

Design, fabrication and assembly of single sided-multilayer and rigid flex printed circuit boards from one (in one day) to one million scheduled. We put the right job in the right plant.  
[www.fpcsales.com](http://www.fpcsales.com)

**[Flexible Circuits- Flexible Circuit Tech](#)**

Flexible Circuit Technologies, with domestic and overseas capabilities, designs and provides flex and rigid-flex circuits in prototype to production quantities.  
[www.flexctech.com](http://www.flexctech.com)

**[Flex Circuit Design and Fabrication](#)**

Lenthor Engineering provides a full service flex, rigid-flex manufacturing environment. Proto to production. Think of us as "Rescue Circuits."  
[www.lenthor.com](http://www.lenthor.com)

**[Flex/Rigid-Flex Design, Fab, Assembly](#)**

Flex Interconnect Technologies (FIT) provides full service - design, fab and assembly for quickturn prototypes to volume production at offshore prices.  
[www.fit4flex.com](http://www.fit4flex.com)

**[Flex Circuits Manufacturer](#)**

Single side, double side, multilayer, rigid-flex. Prototype through production, turn key solution.  
[www.fpcc.com](http://www.fpcc.com)



© 1996-2005 National Geographic Society. All rights reserved.

[Home](#) | [Site Index](#) | [Search](#) | [Free Newsletters](#) | [Subscriptions](#)  
[Shopping](#) | [Contact Us](#) | [Advertise With Us](#) | [Privacy Policy](#) | [Press Room](#)



**NATIONALGEOGRAPHIC.COM**

[Site Index](#) | [Subscribe](#) | [Shop](#) | Search

Go



## NATIONAL GEOGRAPHIC NEWS

REPORTING OUR WORLD DAILY

[Top 15 Most Popular Stories](#)

### NEWS

[Front Page](#)  
[Photo in the News](#)

[Video in the News](#)

[Animals & Nature](#)

[Archaeology & Paleontology](#)

[Environment](#)

[History & Culture](#)

[Science & Space](#)

[Health](#)

[Offbeat](#)

[Travel & Adventure](#)

### SPECIAL SERIES

[The Genographic Project](#)

[Pulse of the Planet](#)

[National Geographic Channel](#)

### RESOURCES

[XML](#) [RSS](#)

[\(What's this?\)](#)

[Contact Us](#)

[Front Page](#) > [Science & Space](#)

## Flexible Electronics One Step Closer With New Circuits

[<< Back](#) | [1](#) | [2](#)

Then they took a piece of elastic rubber, stretched it, and stuck the silicon strips to it.

When the researchers relaxed the strain on the rubber, it returned to its original size. Each silicon strip, stuck to its shrinking foundation, buckled into a wavy, accordion-like shape.

The waves in the silicon's structure were less than 50 micrometers (0.002 inch) long.

When the researchers subsequently stretched or compressed the rubber-and-silicon pieces, the wavelength in the silicon strips expanded or contracted accordingly, without breaking.

Rogers and his colleagues describe their engineering methods and follow-up testing on the wavy circuits in tomorrow's issue of the journal *Science*.

The team has done "very nice work," said Wagner. "It's a step toward any kind of flexible electronics."

Takao Someya of the University of Tokyo's School of Engineering called the advance "one of the major breakthroughs" needed for creating "wearable electronics and/or integration of electronics with biological tissues."

### Applications and Obstacles

Wagner said that, by sculpting circuits, "you can build a spherical lens, like an eye." That could shrink systems of optical sensors to barely a tenth of their current sizes, he said.

"It would be a revolution in digital cameras," he added.

The Princeton engineer also imagines artificial limbs with surface sensors that deliver electrical impulses to severed nerves. And, he said, latex gloves studded with sensors could put information about a patient's vital signs literally at the fingertips of an operating surgeon.

Rogers envisions aircraft wings that sense their own structural health.

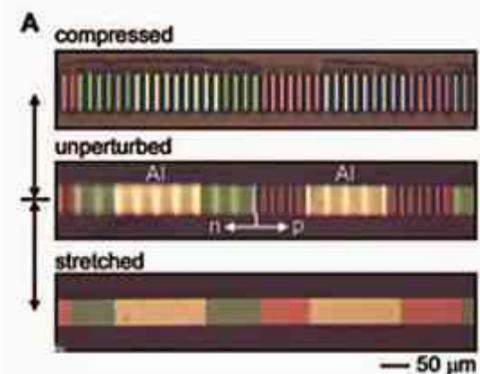
But Wagner says the team's invention falls short of

### TODAY'S MOST POPULAR STORY



[Photo in the News: Oldest Known Maya Mural Reveals Royal Tale](#)

Advertisement



A flexible silicon circuit is shown compressed (top), at rest (middle), and stretched.

This new type of circuit continues to function even as it is bent and pulled. As such, it could pave the way to innovative products, including artificial skin with sensors that "feel," bouncing iPods, and TVs you can twist in knots.

Image courtesy *Science*



### Magazine Savings

Get one year of *National Geographic* for only \$15.

[SUBSCRIBE »](#)

what's necessary for those futuristic uses.

Circuits have to be manufactured in flat sheets, Wagner notes. So to assume complex shapes, such as that of a partial sphere, circuits would need to be what he calls fully deformable.

The new circuitry may be bendable and stretchable, but it's not deformable, Wagner says. "It's not going from flat to a sphere."

Electronics makers such as Samsung and Philips are nevertheless working on flexible electronics.

Initially, experts say, advances are only likely to yield improvements in existing devices, for example by making them more rugged.

The conventional, rigid components in liquid-crystal displays (LCDs)—used in Apple's new video iPods as well as many TVs and computer monitors—are easily broken, Wagner notes.

If iPod video monitors and their like are someday made with bendable components, though, "the screens won't break anymore," he added.

"Flexible displays appear to be the first application likely to be commercialized," Rogers agreed. "You might see these devices in PDAs and so in the next year or two."

#### **Free E-Mail News Updates**

[Sign up for our Inside National Geographic newsletter.](#) Every two weeks we'll send you our top stories and pictures ([see sample](#)).

[<< Back](#) [1](#) | [2](#)

#### **MOST POPULAR STORIES**



#### [Photo in the News: Oldest Known Maya Mural Reveals Royal Tale](#)

Archaeologists have revealed the final wall of the earliest known Maya mural, sa...



#### [Oldest Known Maya Mural, Tomb Reveal Story of Ancient King](#)

Archaeologists have revealed the final wall of the earliest known Maya mural, sa...



#### [King Kong Island Home Is Pure Fantasy, Ecology Experts Say](#)

Skull Island, the mythical home of the great ape King Kong, is supposed to lie i...

#### **RELATED STORIES**

- [Spray-On Solar-Power Cells Are True Breakthrough](#)
- [New Backpack Generates Its Own Electricity](#)
- [Nano-Switches Could Yield Even Smaller Gadgets](#)

Search

#### **RELATED WEB SITES**

- [Science](#)
- [Takao Someya's Curriculum Vitae](#)
- [Department of Chemistry, University of Illinois](#)
- [Sigurd Wagner, Princeton University](#)

#### **ARTICLE TOOLS**

- [E-mail This Story](#)
- [Sign up for Newsletters](#)
- [Reprints/Permissions](#)

#### **SHOP NATIONAL GEOGRAPHIC**

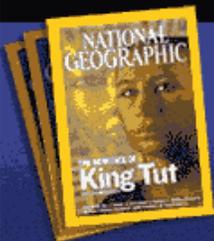


#### **Inside 9/11 DVD Set**

Go beyond what has been reported for a clearer picture of the day that redefined America.

**\$29.95**

[SHOP OUR STORE »](#)



SPECIAL OFFER, SAVE 74%

**Order National Geographic Magazine**

U.S. PRICE IS ONLY

**\$15**

**12 Monthly Issues**

SEND NO MONEY NOW!

Fill in all fields.

Name	<input type="text"/>		
Address	<input type="text"/>	City	<input type="text"/>
State	Select State/Province <input type="button" value="v"/>		
Zip Code	<input type="text"/>	E-mail	<input type="text"/>
<input checked="" type="checkbox"/>	I would like to receive regular e-mail updates.		<input type="button" value="enter order"/>

For Gift Orders,  
Click HereFor International Orders,  
Click Here

Offer applies to U.S. and Canadian addresses only. Savings based on annual U.S. newsstand price of \$59.40. Canadian price C\$20 (\$17 U.S.), including GST. Sales tax will be added where applicable. Allow 4-6 weeks for delivery. While all dues support National Geographic's mission of expanding geographic knowledge, 90 percent is designated for the magazine subscription, and no portion should be considered a charitable contribution.

**Sponsored Links****[Rubber Silicon](#)**

Save on large volume silicones. Get Dow Corning quality at market-driven prices.  
[www.xiameter.com](http://www.xiameter.com)

**[ALT for Quality Material Processing](#)**

Applied Laser Technology offers silicon rubber machining and other specialized, high quality laser services.  
[altinc.com](http://altinc.com)

 **NATIONALGEOGRAPHIC.COM**

© 1996-2005 National Geographic Society. All rights reserved.

[Home](#) | [Site Index](#) | [Search](#) | [Free Newsletters](#) | [Subscriptions](#)  
[Shopping](#) | [Contact Us](#) | [Advertise With Us](#) | [Privacy Policy](#) | [Press Room](#)