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A New Nanogenerator

Researchers are experimenting with a novel nanowire material to power tiny biosensors and portable devices.

By Prachi Patel

Wireless biosensors that monitor pathogens in water and measure blood pressure or cancer biomarkers in the body are shrinking to nanometer dimensions. To operate them, researchers are looking for equally small power sources. Nanowires that convert mechanical energy into electricity are a promising technology.

Now researchers at the University of Illinois at Urbana-Champaign (UIUC) have taken the first step toward building a nanogenerator out of barium titanate. So far, efforts to make nanogenerators have focused on zinc-oxide nanowires. But barium titanate could lead to better generators because it shows a stronger piezoelectric effect, says mechanical-science and engineering professor Min-Feng Yu (https://netfiles.uiuc.edu/mfyu/www/) , who is leading the research at UIUC. Lab experiments show that a barium-titanate nanowire can generate 16 times as much electricity as a zinc-oxide nanowire from the same amount of mechanical vibrations, he says.

Nanogenerators could lead to many advances: biomedical sensors powered by blood flow or muscle contractions, tiny gas sensors that run on wind or acoustic waves, pathogen monitors powered by water flow, and portable electronics that are hooked up to nanowires in shoes. "The nanogenerator idea has become more and more convincing, " says Yi Cui (http://www.stanford.edu/group/cui_group/index.html) , materials-science and engineering professor at Stanford University. "It's an idea that might work."

In 2006, a team of researchers led by Zhong Lin Wang (http://www.nanoscience.gatech.edu/zlwang/wang.html) of the Georgia Institute of Technology first showed that zinc-oxide nanowires could harvest mechanical energy to generate electricity. Wang's group has since made a lot of progress, most recently demonstrating a zinc-oxide nanowire array that outputs direct current in response to ultrasonic vibrations. (See "Nanogenerator Fueled by Vibrations (http://www.technologyreview.com/Nanotech/18496/) .")

The UIUC team is the first to use barium titanate. In an online *Nano Letters* paper (http://pubs.acs.org/cgi-bin/abstract.cgi/nalefd/2007/7/i10/abs/nl070814e.html) , Yu

and his colleagues show that applying vibrations to a single barium-titanate nanowire leads to a small energy output. In their experiment, the researchers bridge a nanowire across a gap on a substrate, keeping one end stationary and moving the other end. The output energy is extremely small--about 0.3 attojoules--but for the same setup, a zinc-oxide nanowire gives 16 times lesssmaller energy output, Yu says.

Xudong Wang (http://www.nanoscience.gatech.edu/zlwang/group/xw.htm) , a researcher in Zhong Lin Wang's (no relation) group and a 2007 TR35 (http://www.technologyreview.com/tr35/) winner, is happy to see progress on using materials other than zinc oxide to make nanogenerators. He says that the results look promising. The biggest advantage with using barium titanate, he feels, is that "it is possible to generate higher voltages than zinc oxide. This is very important for a power source."

But zinc oxide has its own advantages. It is nontoxic to biological systems, so it might be better suited than barium titanate for implantable devices. Also, it is easier to control zinc-oxide growth in order to fabricate nanowire arrays. "To make an applicable device, you need to have many nanowires with the same orientation in the same location," Xudong Wang says. That could be hard to achieve with barium titanate.

Yu acknowledges the difficulties with growing barium-titanate nanowires. His and his colleagues' work is preliminary at this point, he says, but it already shows the potential for making more-efficient, higher-output nanogenerators. As for Cui, he says that barium-titanate nanogenerators might be feasible, but he cautions that "in terms of making a working device, certainly there's still a way to go."

Upcoming Events

The Front End of Innovation (http://www.iirusa.com/feiusa/fei-home.xml)
Boston, MA
Monday, May 18, 2009 - Wednesday, May 20, 2009
http://www.iirusa.com/feiusa/fei-home.xml (http://www.iirusa.com/feiusa/fei-home.xml)

MIT Sloan CIO Symposium: Sustaining CIO Leadership in a Changing Economy (http://www.mitcio.com/)
Cambridge, MA
Wednesday, May 20, 2009
http://www.mitcio.com/ (http://www.mitcio.com/)

TieCon East (http://www.tieconeast.org/2009/)
Boston, MA
Thursday, May 21, 2009 - Friday, May 22, 2009
http://www.tieconeast.org/2009/ (http://www.tieconeast.org/2009/)

2009 Medical Innovation Summit
(http://www.ClevelandClinic.org/innovations/summit)
Cleveland, OH
Monday, October 05, 2009 - Wednesday, October 07, 2009
http://www.ClevelandClinic.org/innovations/summit
(http://www.ClevelandClinic.org/innovations/summit)