

3-D view of 1-D nanostructures

January 6 2012



This is a diagram of a single nanowire piezoelectricity. Credit: Image courtesy Horacio Espinosa

Semiconductor gallium nitride nanowires show great promise in the next generation of nano- and optoelectronic systems. Recently, researchers at the McCormick School of Engineering have found new piezoelectric properties of the nanowires that could make them more useful in selfpowered nanodevices.

Just 100 nanometers in diameter, nanowires are often considered onedimensional. But researchers at Northwestern University have recently reported that individual <u>gallium nitride</u> nanowires show strong <u>piezoelectricity</u> – a type of charge-generation caused by mechanical



stress – in three dimensions.

The findings, led by Horacio Espinosa, James N. and Nancy J. Farley Professor in Manufacturing and Entrepreneurship at the McCormick School of Engineering and Applied Science, were published online Dec. 22 in *Nano Letters*.

Gallium nitride (GaN) is among the most technologically relevant semiconducting materials and is ubiquitous today in optoelectronic elements such as blue lasers (hence the blue-ray disc) and light-emittingdiodes (LEDs). More recently, nanogenerators based on GaN nanowires were demonstrated capable of converting mechanical energy (such as biomechanical motion) to electrical energy.

"Although nanowires are one-dimensional <u>nanostructures</u>, some properties – such as piezoelectricity, the linear form of electromechanical coupling – are three-dimensional in nature," Espinosa said. "We thought these nanowires should show piezoelectricity in 3D, and aimed at obtaining all the piezoelectric constants for individual nanowires, similar to the bulk material."

The findings revealed that individual GaN nanowires as small as 60 <u>nanometers</u> show piezoelectric behavior in 3D up to six times of their bulk counterpart. Since the generated charge scales linearly with piezoelectric constants, this finding implies that nanowires are up to six times more efficient in converting mechanical to electrical energy.

To obtain the measurements, researchers applied an electric field in different directions in single nanowire and measured small displacements, often in pico-meter (10-12 m) range. The group devised a method based on scanning probe microscopy leveraging high-precision displacement measurement capability of an atomic force microscope.



"The measurements were very challenging, since we needed to accurately measure displacements 100 times smaller than the size of the hydrogen atom," said Majid Minary, a postdoctoral fellow and the lead author of the study.

These results are exciting especially considering the recent demonstration of nanogenerators based on GaN nanowires, for powering of self-powered <u>nanodevices</u>.

Provided by Northwestern University

Citation: 3-D view of 1-D nanostructures (2012, January 6) retrieved 27 April 2024 from <u>https://phys.org/news/2012-01-d-view-nanostructures.html</u>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.