First practical nanogenerator produces electricity with pinch of the fingers

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After six years of intensive effort, scientists are reporting development of the first commercially viable nanogenerator, a flexible chip that can use body movements — a finger pinch now en route to a pulse beat in the future — to generate electricity. Speaking here today at the 241st National Meeting & Exposition of the American Chemical Society, they described boosting the device's power output by thousands times and its voltage by 150 times to finally move it out of the lab and toward everyday life.

"This development represents a milestone toward producing portable electronics that can be powered by body movements without the use of batteries or electrical outlets," said lead scientist Zhong Lin Wang, Ph.D. "Our nanogenerators are poised to change lives in the future. Their potential is only limited by one's imagination."

The latest improvements have resulted in a nanogenerator powerful enough to drive commercial liquid-crystal displays, light-emitting diodes and laser diodes. By storing the generated charges using a capacitor, the output power is capable to periodically drive a sensor and transmit the signal wirelessly.

"If we can sustain the rate of improvement, the nanogenerator may find a broad range of other applications that require more power," he added. Wang cited, for example, personal electronic devices powered by footsteps activating nanogenerators inside the sole of a shoe; implanted insulin pumps powered by a heart beat; and environmental sensors

powered by nanogenerators flapping in the breeze.

Wang and colleagues demonstrated commercial feasibility of the latest nanogenerator by using it to power an LED light and a liquid crystal display like those widely used in many electronic devices, such as calculators and computers. The power came from squeezing the nanogenerator between two fingers.

The key to the technology is zinc oxide (ZnO) nanowires. ZnO nanowires are piezoelectric — they can generate an electric current when strained or flexed. That movement can be virtually any body movement, such as walking, a heartbeat, or blood flowing through the body. The nanowires can also generate electricity in response to wind, rolling tires, or many other kinds of movement.

The diameter of a ZnO nanowire is so small that 500 of the wires can fit inside the width of a single human hair. Wang's group found a way to capture and combine the electrical charges from millions of the nanoscale zinc oxide wires. They also developed an efficient way to deposit the nanowires onto flexible polymer chips, each about a quarter the size of a postage stamp. Five nanogenerators stacked together produce about 1 micro Ampere output current at 3 volts — about the same voltage generated by two regular AA batteries (about 1.5 volts each).

"While a few volts may not seem like much, it has grown by leaps and bounds over previous versions of the nanogenerator," said Wang, a scientist at Georgia Institute of Technology. "Additional nanowires and more nanogenerators, stacked together, could produce enough energy for powering larger electronics, such as an iPod or charging a cell phone."

Wang said the next step is to further improve the output power of the nanogenerator and find a company to produce the nanogenerator. It

could hit the market in three to five years, he estimated. The device's first application is likely to be as a power source for tiny environmental sensors and sensors for infrastructure monitoring.

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