Team made great improvements of nanogenerator power efficiency

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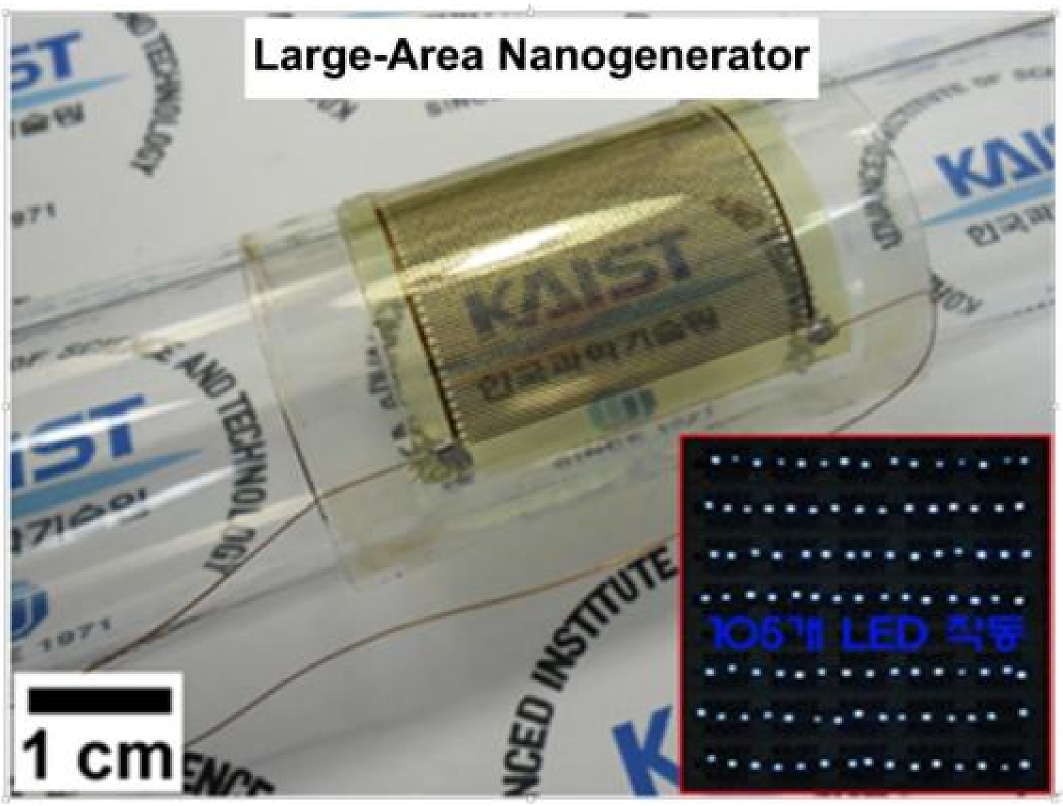


This is a photograph of large-area PZT thin film nanogenerator (3.5 cm × 3.5 cm) on a curved glass tube and 105 commercial LEDs operated by self-powered flexible piezoelectric energy harvester. Credit: KAIST

Nanogenerators are innovative self-powered energy harvesters that convert kinetic energy created from vibrational and mechanical sources into electrical power, removing the need of external circuits or batteries for electronic devices. This innovation is vital in realizing sustainable energy generation in isolated, inaccessible, or indoor environments and even in the human body.

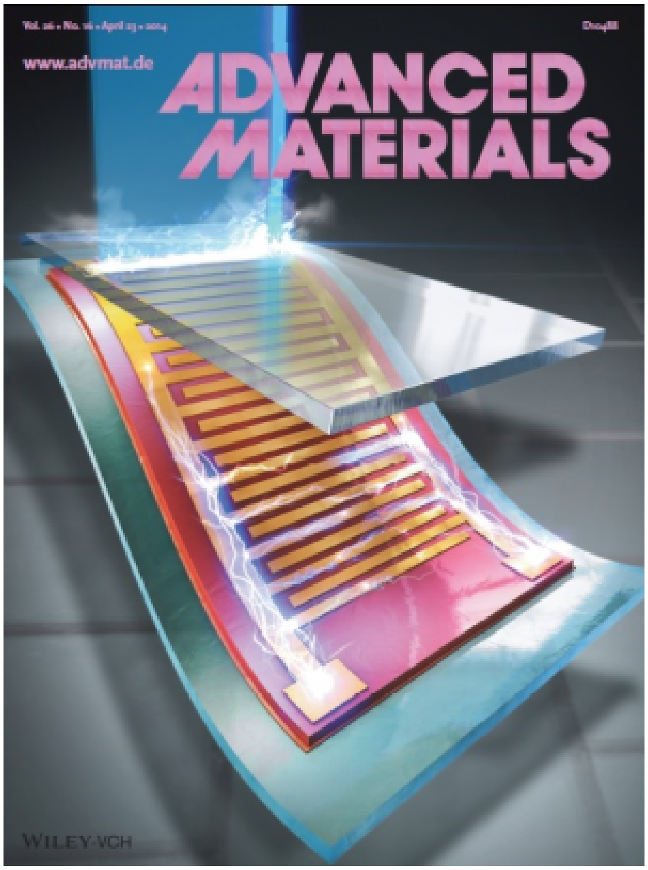
Nanogenerators, a flexible and lightweight energy harvester on a plastic substrate, can scavenge energy from the extremely tiny movements of natural resources and human body such as wind, water flow, heartbeats, and diaphragm and respiration activities to generate electrical signals. The generators are not only self-powered, flexible devices but also can provide permanent power sources to implantable biomedical devices, including cardiac pacemakers and deep brain stimulators.

However, poor energy efficiency and a complex fabrication process have posed challenges to the commercialization of nanogenerators. Keon Jae Lee, Associate Professor of Materials Science and Engineering at KAIST, and his colleagues have recently proposed a solution by developing a robust technique to transfer a high-quality piezoelectric thin film from bulk sapphire substrates to plastic substrates using laser lift-off (LLO).

Applying the inorganic-based laser lift-off (LLO) process, the research team produced a large-area PZT thin film nanogenerators on flexible substrates (2 cm x 2 cm).

"We were able to convert a high-output performance of ~250 V from the slight mechanical deformation of a single thin plastic substrate. Such output power is just enough to turn on 100 LED lights," Keon Jae Lee explained.

The self-powered nanogenerators can also work with finger and foot motions. For example, under the irregular and slight bending motions of a human finger, the measured current signals had a high electric power of ~8.7 μA. In addition, the piezoelectric nanogenerator has worldrecord power conversion efficiency, almost 40 times higher than previously reported similar research results, solving the drawbacks related to the fabrication complexity and low energy efficiency.



This picture shows a flexible PZT thin film nanogenerator using inorganic-based laser lift-off process. Credit: KAIST

Lee further commented, "Building on this concept, it is highly expected that tiny mechanical motions, including human body movements of muscle contraction and relaxation, can be readily converted into electrical energy and, furthermore, acted as eternal power sources."

The research team is currently studying a method to build threedimensional stacking of flexible piezoelectric thin films to enhance output power, as well as conducting a clinical experiment with a flexible nanogenerator.

More information: This research result, entitled "Highly-efficient, Flexible Piezoelectric PZT Thin Film Nanogenerator on Plastic Substrates," was published as the cover article of the April issue of *Advanced Materials*: onlinelibrary.wiley.com/doi/10 … a.201305659/abstract

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