
Japanese Researchers Develop Flexible MoS₂-based Nanogenerator Suitable for Powering IoT Devices

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Scientists have developed an energy harvesting device that generates over 5 volts of electricity from a liquid droplet. This device, made of flexible thin films, generates electricity when drops of liquid slide down along its surface. This technology is expected to be applied to IoT devices, such as self-powered sensors to monitor the quality of industrial wastewater.

Energy harvesting, a technology to transform small quantities of naturally occurring energy (e.g. light, heat, and vibration) into electricity, is gaining attention as a method to power the Internet of Things ([IoT](#)) devices. This technology helps reduce environmental impacts and has the potential to power electronic devices in a stable and long-term manner, unlike batteries that need recharging or replacing.

Researchers at [Nagoya University](#) and [Kyushu University](#) focused on energy from the tiny movement of liquid and developed a device that generates over 5 volts of electricity directly from the movement of a liquid droplet. This device, made of flexible thin films, generates electricity when drops of water slide down on its upper surface. This technology is expected to be applied to self-powered devices used in liquids, including sensors monitoring the quality of wastewater from factories. Their findings have been published in the journal Nano Energy.

Energy generated from the tiny flow of liquid exists in various environments, such as inside of factory pipes, and in micro-fluid devices, but this kind of energy has not been used effectively so far. It has been shown that a graphene sheet can generate electricity from the liquid movement across its surface. However, its output voltage is limited to about 0.1 volt, which is not enough to drive electronic devices.

The research group, consisting of Nagoya University's Adha Sukma Aji, Ryohei Nishi, and Yutaka Ohno and Kyushu University's Hiroki Ago, has demonstrated that using molybdenum disulfide (MoS₂) instead of graphene as the active material in the generator makes it possible

to generate over 5 volts of electricity from a liquid droplet.

"To use MoS₂ for the generator, it was necessary to form a large-area single-layer MoS₂ film on a plastic film. With conventional methods, however, it was difficult to grow MoS₂ uniformly on a large-area substrate," says Professor Ohno of the Institute of Materials and Systems for Sustainability at Nagoya University. "In our study, we succeeded in fabricating this form of MoS₂ film by means of chemical vapor deposition using a sapphire substrate with molybdenum oxide (MoO₃) and sulfur powders. We also used a polystyrene film as a bearing material for the MoS₂ film, so that we were able to transfer the synthesized MoS₂ film to the surface of the plastic film quite easily."

The newly developed generator is flexible enough to be installed on the curved inner surface of plumbing and is thus expected to be used to power IoT devices used in liquids, such as self-powered rain gauges and acid rain monitors, as well as water quality sensors that can generate power from industrial wastewater while monitoring it.

Professor Ohno says, "Our MoS₂ nanogenerator is able to harvest energy from multiple forms of liquid motion, including droplets, spraying, and sea waves. From a broader perspective, this device could also be used in applications involving hydrodynamics, such as generating electricity from rainwater and waterfalls."

The article, "High output voltage generation of over 5 V from liquid motion on single-layer MoS₂," was published online in the journal [Nano Energy](#). This work was supported by the [Japan](#) Science and Technology Agency CREST program (JPMJCR16Q2).

Read the [original article](#) on Nagoya University.