Energy harvester collects energy from sunlight and raindrops

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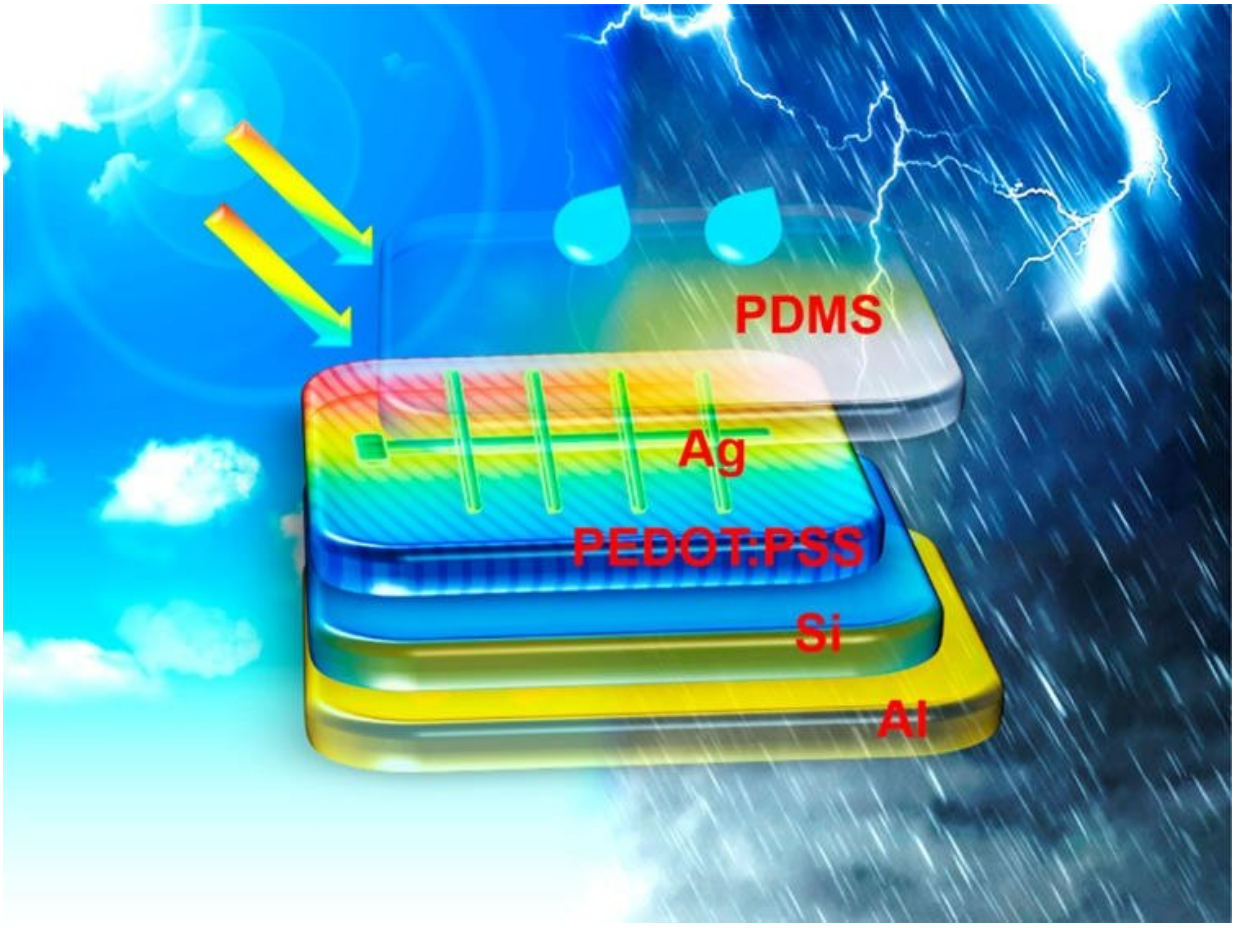

Hybrid device harvests energy from sunlight and raindrops: A transparent PDMS nanogenerator integrated with a silicon solar cell by sharing a mutual electrode made of PEDOT:PSS film. Credit: Liu et al. ©2018 American Chemical Society

By attaching a transparent nanogenerator to a silicon solar cell, researchers have designed a device that harvests solar energy in sunny conditions and the mechanical energy of falling raindrops in rainy conditions. The dual functionality may provide a way to harvest energy with greater consistency in the midst of constantly changing weather conditions.

The researchers, Yuqiang Liu et al., at Soochow University in China, have published a paper on the hybrid device in a recent issue of *ACS Nano*.

The hybrid device consists of a conventional silicon solar cell and a triboelectric nanogenerator (TENG), which converts the mechanical energy of falling raindrops into electricity. Although previous research has shown that these two types of devices can be connected with an extra wire, in the new design the solar cell and TENG are integrated by sharing a mutual electrode.

"The biggest breakthrough in this work is that an integrated generator composed of a solar cell and a TENG was demonstrated through sharing a mutual electrode," coauthor Zhen Wen at Soochow University told *Phys.org*. "Compared to previous work, the simple design of the mutual electrode reduces the number of functional layers, which greatly improves the output efficiency."

The shared electrode not only results in a more compact design, but it also offers advantages to both the solar cell and TENG. In particular, the TENG protects the solar cell by acting as a waterproof barrier and prevents water from penetrating the silicon. The textured electrode surface also greatly suppresses unwanted reflection of light, enhancing light harvesting. Further, the textured surface results in a greater contact area between the TENG and falling rain drops, which improves the overall performance of the nanogenerator.

One challenge that remains to be addressed is the minor drawback that the solar cell and TENG cannot function simultaneously.

"Due to the design of the mutual electrode, the solar cell and nanogenerator cannot work together," Wen said. "So if there is a sunshower (sunshine and raindrops appearing at the same time), we have to give up one function of the hybrid generator. But I don't think that is often the case."

In the future, the researchers plan to explore integrating the hybrid device into electronic clothing.

"Due to the unique design, it has advantages of being lightweight and having a high efficiency," Wen said. "We are now designing a fiber-shaped device and expect to weave them together as a fabric. My wish is to fabricate clothing that can generate electricity from sunshine and raindrops, and then use this electricity to power wearable electronic devices."

More information: Yuqiang Liu et al. "Integrating a Silicon Solar Cell with a Triboelectric Nanogenerator via a Mutual Electrode for Harvesting Energy from Sunlight and Raindrops." *ACS Nano*. DOI: 10.1021/acsnano.8b00416