Hybrid energy harvester generates electricity from vibrations and sunlight

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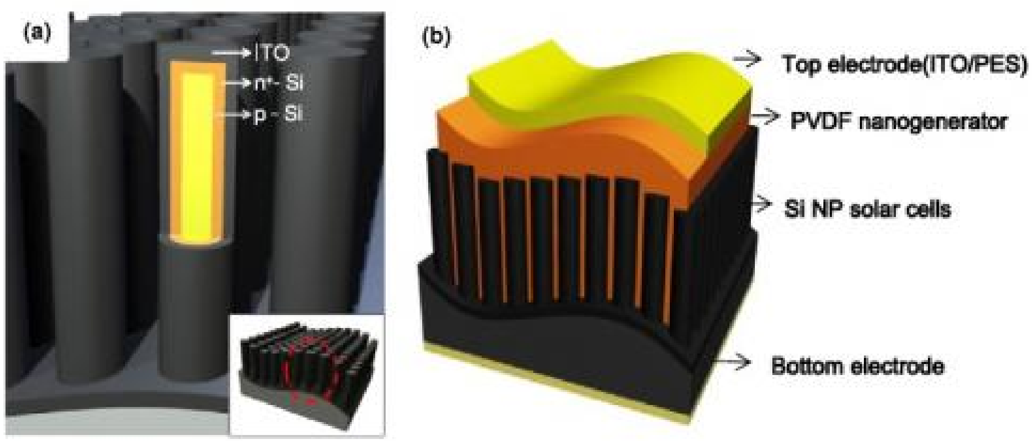

(a) Diagram of the silicon nanopillar solar cell. (b) Diagram of the hybrid energy harvester consisting of a piezoelectric nanogenerator integrated on to of a silicon nanopillar solar cell. Credit: Dae-Yeong Lee, et al. ©2013 IOP Publishing Ltd

(Phys.org) —Devices that harvest energy from the environment require specific environmental conditions; for instance, solar cells and piezoelectric generators require sunlight and mechanical vibration, respectively. Since these conditions don't exist all the time, most energy harvesters don't generate a constant stream of electricity. In order to harvest ubiquitous energy continuously, researchers have designed and fabricated a hybrid energy harvester that integrates a solar cell and piezoelectric generator, enabling it to harvest energy from both sunlight and sound vibration simultaneously.

The researchers, Dae-Yeong Lee, et al., from Sungkyunkwan University and Samsung Advanced Institute of Technology, both in South Korea, have published their study on the hybrid energy harvester in a recent issue of *Nanotechnology*.

"By using the hybrid energy harvester, two different energy sources can be utilized in one platform," coauthor Hyunjin Kim at the Samsung Advanced Institute of Technology told *Phys.org*. "Thus the total output power from the hybrid harvester can be increased compared to each separate harvester. Furthermore, by harvesting two energy sources in one device, continuous output can be generated even when only one energy source is available."

To design the harvester, the researchers turned to silicon nanopillar solar cells for the sunlight harvesting half of the device. Previous research has shown that silicon nanopillar solar cells are promising candidates as photovoltaic devices due to their low reflection, high absorption, and potential for low-cost mass production.

After fabricating the cells using a plasma etching technique and annealing processes, the researchers coated the top of each cell to prepare it for placement of the piezoelectric generator, which was stacked on top using a spin coating method. Last, top and bottom electrodes sandwich the device.

The entire harvester has a height of just a few hundred nanometers, with the bulk of the height coming from the 300-nm-tall nanopillars in the solar cell.

In tests, the energy harvester could generate electricity from the solar cells with a 3.29% conversion efficiency. At the same time, the harvester could generate 0.8 V of output voltage when exposed to a 100-dB sound.

The hybrid device suggests that harvesting both solar and vibration energies can enable more efficient harvesting in certain environments compared to a device that harvests just one kind of energy.

"This energy harvester can be very useful where there is no electric grid connected," coauthor Won Jong Yoo at Sungkyunkwan University said. "For example, this device will be useful in moving vehicles such as moving boats, trains, automobiles, etc. The output of 0.8 V is just preliminary data. If we optimize the device structure and fabrication condition, the output power will be increased significantly."

In the future, the researchers plan to fabricate all-flexible hybrid energy harvesting devices using plastic substrates in order to harvest mechanical energy more efficiently.

More information: Dae-Yeong Lee, et al. "Hybrid energy harvester based on nanopillar solar cells and PVDF nanogenerator." *Nanotechnology* 24 (2013) 175402 (6pp). DOI: 10.1088/0957-4484/24/17/175402