Research Highlights

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Thermoelectric Device Combined with Wavelength-selective Thermal Emitter Generates Continuous Power, Day and Night

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A team at MANA has created a thermoelectric device that can generate power continuously, 24 hours a day, without the problem of voltage dropping to zero when night falls and temperatures drop.

Thermoelectric devices have been attracting attention for energy harvesting, especially those that require independent power supply, such as outdoor sensors and monitors. Such devices, which are more ubiquitous than photovoltaics, only require temperature difference between its top and bottom to generate power.

However, thermoelectric devices placed outside experience reversal of voltage when temperatures change -- they flip the sign of their voltage, and the electrical current changes its direction of flow, so the voltage drops to zero and power generation ceases.

To address this problem, the MANA team built their device with a wavelength-selective emitter that continually radiates heat, so that its surface temperature is always cooler than the bottom side of the thermoelectric module, which is placed below the selective emitter.

The device consists of a 100-nanometer-thick aluminum film on the bottom of a glass substrate.

Because the top of the device is cooler than the bottom, the temperature difference creates constant voltage all day and night.

The team found that using a selective emitter eliminates the problem of voltage dropping to zero during environmental changes in temperature.

As team leader Satoshi Ishii noted, “Cooling can be used to create a temperature difference compared to the ambient temperature, and because radiative cooling takes place day and night, thermoelectric generation is always possible.”

The larger the temperature difference, the larger the voltage. Using the heat on the underside of the device increases the temperature difference between the bottom and top, so heat from the mounting surface helps boost power output as well.

This research was carried out by Satoshi Ishii (Principal Researcher, Photonics Nano-Engineering Group) and his collaborators.

Reference

“Radiative cooling for continuous thermoelectric power generation in day and night”
Satoshi Ishii, Thang Duy Dao and Tadaaki Nagao
Journal: Applied Physics Letters 117 [1] 013901 (July 7, 2020)
DOI : 10.1063/5.0010190

■ Related News articles
Satoshi Ishii, Principal Researcher and his colleague's research announced as a press release in American Institute of Physics (AIP) (July 9, 2020)
Satoshi Ishii, Principal Researcher Appears in Newspapers (September 2, 2020)

■ MANA E-BULLETIN
https://www.nims.go.jp/mana/ebulletin/

Affiliations

International Center for Materials Nanoarchitectonics (WPI-MANA), National Institute for Materials Science (NIMS), Namiki 1-1, Tsukuba, Ibaraki 305-0044, Japan

Contact information

International Center for Materials Nanoarchitectonics(WPI-MANA)

National Institute for Materials Science
1-1 Namiki, Tsukuba, Ibaraki 305-0044 Japan
Phone: +81-29-860-4710
E-mail: mana-pr[AT]ml.nims.go.jp