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NEC Corporation
Tohoku University

NEC and Tohoku University develop a new device for generating electricity from easily accessible heat sources

NEC Corporation (NEC; TSE: 6701) and Tohoku University have developed a new thermoelectric (TE) device[*1], which generates electricity from readily available thermal energy using the spin Seebeck effect[*2].

This device can be applied with simple coating processes on a wide variety of heat sources, such as electronic equipment and vehicles, to enable the recovery and utilization of wasted heat as useful electricity.

Large amounts of heat are generated from a broad range of sources, but most of this heat just goes to waste. TE conversion technology has long been expected to recover such wasted heat. However, the complex structure of conventional TE devices has hindered a wide range of applications.

This new TE device, developed by NEC and Tohoku University, overcomes this issue by using the “spin Seebeck effect,” where a spin current is generated by a temperature gradient in magnetic materials. This leads to a notably simple device structure, which can be produced by easier coating processes in comparison to conventional devices.

The coating-based new device is capable of recovering heat from various shaped heat sources that cover a large area, which is difficult to achieve with conventional TE devices. Furthermore, the spin Seebeck effect can potentially offer highly efficient heat conversion, paving the way for efficient recovery of wasted heat.

The following are key features of the new thermoelectric device:

1. Simple structure that enables easy production

The device uses a simple two-layered structure formed with magnetic and metallic films on the surface of heat generating components. In the magnetic film, a spin current is driven by a temperature gradient as a result of the spin Seebeck effect. The spin current is ultimately converted into electricity in the metallic film. This simple structure can be produced by much easier processes when compared to the conventional TE devices where a number of thermocouples[*3] are connected electrically in series.

2. Coating process that is applicable on different shaped heat sources

Since a coating process is used for forming the magnetic layer, it can be applied on curved and uneven surfaces of heat-source materials over a large area, greatly enhancing the applicability of the TE device.

Going forward, NEC Corporation and Tohoku University will continue R&D on practical applications of the new TE device.

Part of this work is achieved through “Generation of Nanointegration of Heat, Electricity, and Motion by Spin Current” (Research Director: Eiji Saitoh) research under the JST-CREST “Creation of Nanosystems with Novel Functions through Process Integration” (Research Supervisor: Jun-ichi Sone, Vice President, National Institute of Materials Science) project in Japan.

Results of this research are published in Nature Materials.

Notes:

(1*) Thermoelectric (TE) device: A device that converts thermal energy to electricity.

(2*) Spin Seebeck effect: A phenomenon where spin current, which is a flow of a magnetic moment of an electron, is generated by a temperature gradient across magnetic materials. This phenomenon was discovered by Tohoku University Professor Eiji Saitoh in 2008, when he was still with Keio University. In 2010, Professor Saitoh also demonstrated the spin Seebeck effect on non-conducting magnetic materials.
(3*) Thermocouple: A device consisting of a junction of two different kinds of metals or semiconductors that produce a voltage proportional to the temperature difference between either ends of the two conductors.

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