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Flexible thermoelectric Device: From materials to applications

Thermoelectric (TE) materials offer a way to convert waste heat energy into electrical power, based on the Seebeck effect. The TE energy-harvesting mechanism of a material is that when a temperature gradient (ΔT) is applied, the charge carriers (electrons for n-type materials or holes for p-type materials) from the hot side diffuse to the cold side. As a result, an electrostatic potential (ΔV) is induced. TE materials can also convert electrical power into thermal energy (i.e., cooling or heating) based on the Peltier effect. The Peltier effect is essentially the inverse of the Seebeck effect. TE devices exhibit many advantages, such as having no moving parts, no moving fluids, no noise, easy (or no) maintenance, and high reliability. The typical structure of a thermoelectric device is between Al_2O_3 (a type of ceramic) substrate. Al_2O_3 is an inflexible and hard material. Unfortunately, many devices that offer heat sources have arbitrary shapes rather than flat surfaces. It is therefore difficult to capture the heat efficiently with the conventional flat and inflexible thermoelectric device. The present work reports on the fabrication of flexible thermoelectric device. The device was fabricated on polymer substrate using Bi2Te3 and Sb2Te3 thermoelectric elements. In the end, we point out the challenges and outlook for the future application of flexible thermoelectric materials and devices.

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