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3D Printing Nanostructured Thermoelectric Device

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ABSTRACT

Thermoelectric materials convert thermal energy to electrical energy and vice versa. Thermoelectrics have attracted much attention and research efforts due to the possibility solving electronic cooling problems and reducing energy consumption through waste heat recovery. The efficiency of a thermoelectric material is determined by the dimensionless figure of merit ZT, which depends on both thermal and electrical properties. Researchers have worked for several decades to improve the ZT, but there had been little progress until nanomaterials and nanofabrication became widely available. Nanotechnology makes the ZT enhancement attainable by disconnecting the linkage between thermal and electrical transport. Printing customized, flexible thermoelectric devices opens the door to new applications and energy saving solutions, while probing the impact of different structure on properties and performance. This study combines nanostructured materials with 3D printing technology to enable development of customized thermoelectric devices with mechanical flexibility, which is not possible in commercially-available devices. A 3D printer is fabricated to allow printing of nanostructured thermoelectric inks, and can print customized devices by controlling the movement of the substrates and the mechanisms of ink dispensing. The properties and performance of the devices are measured with the modified Harman method. Although the selected nanoink (zinc oxide in ethanol) yields low figures of merit, this work demonstrates the feasibility of using 3D printing to fabricate flexible thermoelectric devices. This technology will contribute to ongoing research of energy recycling and waste heat recovery.

KEYWORDS

nanotechnology, thermoelectric material, 3D printing, nanoink, heat recovery