ANISOTROPIC THERMOELECTRIC DEVICES BASED ON SINGLE-CRYSTAL SEMIMETAL MICROWIRES AND FILMS

Leonid Konopko, Albina Nikolaeva, Denis Shiversky
Technical University of Moldova, Institute of Electronic Engineering and Nanotechnologies “D. GHITU”,
Academiei str., 3/3, Chisinau, Moldova

Thermoelectric heat conversion based on the Seebeck and Peltier effects generated at the junction between two materials of type-*n* and type-*p* is well known. Here, we present a demonstration of an unconventional thermoelectric energy conversion that is based on a single element made of an anisotropic material. In such materials, a heat flow generates a transverse thermoelectric electric field lying across the heat flow. Potentially, in applications involving miniature devices, the anisotropic thermoelectric effect has the advantage over traditional thermoelectrics that it simplifies the thermoelectric generator architecture. A feature of anisotropic thermoelectrics is that the thermoelectric voltage is proportional to the element length and inversely proportional to the effective thickness. We have prepared an experimental sample consisting of a 10-m-long glass-insulated single-crystal tin-doped bismuth microwire (D=20 µm, d=4 µm) [1,2]. Crucial for this experiment is the ability to grow the microwire as a single-crystal using a technique of recrystallization with laser heating and under a strong electric field. The sample was wound as a spiral, bonded to a copper disk, and used in various experiments. The sensitivity of the sample to heat flow is as high as 10^{-2} V/W with a time constant *s* of about 0.5 s. Polycrystalline Bi films with a thickness of 2-5 µm were deposited on the mica support by the vacuum thermal evaporation method. Experimental samples of heat flux sensors were made on the basis of recrystallized Bi films under laser heating and in a strong electric field.

This study was supported by the Project no. 020201 "Nanostructures and advanced materials for implementation in spintronics, thermoelectricity and optoelectronics".

References:
1. L. Konopko, A. Nikolaeva, A. Kobylianskaya, T. Huber. Anisotropic thermoelectric devices made from single-crystal semimetal microwires in glass coating. *J. Electron. Mater.* 2018, 47, 3171-3176. https://doi.org/10.1007/s11664-018-6272-z.
2. L. Konopko, A. Nikolaeva, T. Huber, A. Kobylianskaya. Miniaturized heat-flux sensor based on a glass-insulated Bi–Sn microwire. *Semiconductors,* 2019, 53, 662–666. https://doi.org/10.1134/S1063782619050117.
Corresponding author: Dr. Leonid Konopko
UTM, Institute of Electronic Engineering and Nanotechnologies “D. GHITU”
Academiei 3/3, Chisinau MD2028, Moldova
e-mail: leonid.konopko @iien.utm.md
ORCID: 0000-0002-5734-212X