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Topological insulators based on layers and foils for thermoelectric microcooling devices

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Abstract

We preset the results of the study on thermoelectric properties and oscillatory effects layers and foils) based on p-type Bi2Te3 topological insulators and n-type Bi0.84Sb0.16 foils (d=10-20 μ m). Analysis of the Shubnikov de Haas oscillations of p-type Bi2Te3 single-crystal layers has confirmed the presence of surface states in layers with a high quantum charge carrier mobility of up to 20 × 103 cm2/(V s) and a Fermi surface anisotropy of A = 4, which are characteristic of bulk topological insulator. It has been revealed that the thermal conductivity of the foils in a temperature range of 300 100 K remains constant. Based on a technology developed by the authors for forming unsupported p-type Bi2Te3 single-crystal micro-layers and an n-type Bi0.84Sb0.16 foils a device was constructed that provides a temperature gradient of ?T = 9 K over an area of 0.01 cm2. Structures based on Bi2Te3 can be used to design miniature sensors for thermoelectric devices, such as thermoelectric coolers, in particular, for cooling a computer processor.

Keywords: *bismuth telluride, microcooler, foil, microlayers, thermoelectricity, topological insulators*

References:

1. *D.V. Rowe, Thermoelectric handbook: macro to nano, Boca Raton:Taylor Francls, pp. 1008, 2006.* Google Scholar
2. *O. Yamashita, S. Tomiyoshi and K. Makita, "Bismuth telluride compounds with high thermoelectric figures of merit", Journal of Applied Physics, vol. 93, pp. 368-374, 2003.* CrossRef Google Scholar
3. *Takahashi Ryuji and Murakami Shuichi, "Thermoelectric transport in topological insulators in the spin helical Dirac transport regime", Nature, vol. 460, pp. 1101-1105, 2009.* Google Scholar

4. J.P. Heremans, "Low dimensional thermoelectricity", Acta Physica Polonica, vol. 108, pp. 609-634, 2005. CrossRef Google Scholar
5. O. Rabin, Y.M. Lin and M.S. Dresselhaus, "Anomalously high thermoelectric figure of merit in Bi1-xSbx nanowires by carrier pocket alignment", Appl Phys Lett, vol. 79, pp. 81-83, 2001. CrossRef Google Scholar
6. P. Lardson, S.D. Mahanti and M.G. Kanatzidis, "Electronic structure and transport of Bi2Te3 and BaBiTe3", Phys.Rev. B, vol. 61, pp. 8162-8171, 2000. CrossRef Google Scholar
7. V. Goyal, D. Teweldebrhan and A. Balandin, "Mechanically-exfoliated stacks of the films of Bi2Te3 topological insulator", Appl Phys Lett, vol. 97, pp. 133117, 2010. CrossRef Google Scholar
8. A.V. Demidchik and V.G. Shepelevich, "Structure and electronic spectrum of fullerene-like nanoclusters based on Mo Nb Zr and Sn disulfides", Inorganic Materials, vol. 40, pp. 391-395, 2004. CrossRef Google Scholar
9. L. Konopko, A. Nikolaeva, T. Huber and D. Meglei, "Thermoelectric properties of Bi2Te3 microwires", Phys. Status Solidi C, vol. 11, pp. 1377-1381, 2014. CrossRef Google Scholar