



Size-Quantization Semimetal–Semiconductor Transition in $\text{Bi}_{0.98}\text{Sb}_{0.02}$ Nanowires: Thermoelectric Properties

Nikolaeva A. A., Konopko L. A., Huber T. E., Bodiul P. P., Popov I. A., Moloshnik E. F.

<https://doi.org/10.1007/s11664-012-2090-x>

Abstract

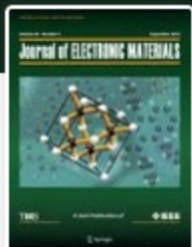
In this work, we study glass-coated single-crystal $\text{Bi}_{0.98}\text{Sb}_{0.02}$ wires obtained by liquid phase casting.

Semimetal $\text{Bi}_{0.98}\text{Sb}_{0.02}$ nanowires exhibited a “semiconductor” behavior of the temperature dependence $R(T)$ for wire diameters <400 nm, which is significantly higher than the critical diameter (70 nm) for similar dependences $R(T)$ of pure bismuth nanowires. The thermopower sign reversal in the temperature dependence $\alpha(T)$ was found to depend on the wire diameter d . The effect is interpreted in terms of manifestation of the quantum size effect, based on the appearance a new scattering channel stimulated by fluctuations in the diameter d .

The effect of negative magnetoresistance in a perpendicular magnetic field was observed for the first time both at $H \parallel C_3$ and $H \parallel C_2$ in magnetic fields of 1 T.

It is shown that a semimetal-semiconductor transition can be controlled using an elastic strain and a strong magnetic field, which lead to a significant shift of the band boundaries of the energy extrema in the bands.

Keywords: glass-coated single-crystals wires, liquid phase casting, semimetal nanowires, bismuth nanowires, magnetic fields



Journal of Electronic Materials

2012, Volume 41, Number 9, pag. 2313-2316

References

1. C.B. Thomas, and H.I. Goldsmid, *J. Phys. Lett.*, **27A**, N6, 369 (1968).
[Article](#)
[Google Scholar](#)
2. G.A. Ivanov, V.A. Kulikov, V.L. Naletov, A.F. Panarin, A.R. Repel, *FTP*, **6**, 1296 (1972).
[CAS](#)
[Google Scholar](#)
3. L.I. Anatyshuk, *J. of Thermoelectricity*, **2**, 348 (2005).
[Google Scholar](#)
4. L.A. Falkovskii, *UFN*, **94**, 3 (1988).
[Article](#)
[Google Scholar](#)
5. G. Oelgard, G. Schneider, W. Kraak, R. Herrmann, *J. Phys. St. Sol. (b)*, **74**, N1, k75 (1976).
[Article](#)
[Google Scholar](#)
6. St. Golin, *J. Phys. Rev.*, **176**, N3, 830 (1968).
[CAS](#)
[Article](#)
[Google Scholar](#)
7. L.S. Lerner, K.F. Cuff, L.R. Williams, *J. Rev. of Mod. Phys.*, **40**, N4, 770 (1968).
[CAS](#)
[Article](#)
[Google Scholar](#)
8. N.B. Brandt, H. Dittman, Ya.G. Ponomarev, *FTT*, **15** 824 (1973).
[CAS](#)
[Google Scholar](#)
9. N.B. Brandt, R. Muller, Ya.G. Ponomarev, *JETP*, **71**, 2268 (1976).
[CAS](#)
[Google Scholar](#)
10. Yu-Mong Lin, X. Sun, and M.S. Dresselhaus, *J. Phys. Rev. B*, **62**, N7, 4610 (2000).
[CAS](#)
[Article](#)
[Google Scholar](#)
11. L.D. Hicks, and M.S. Dresselhaus, *J. Phys. Rev. B*, **47**, 15631 (1993).
[Google Scholar](#)
12. O. Rabin, Yu-Ming Lin, and M. S. Dresselhaus, *J. Phys. Rev. B*, **79**, N1, 81 (2001).
[Google Scholar](#)
13. Yu-Ming Lin, O. Rabin, S.V. Cronin, Jackie Y. Ying, and M.S. Dresselhaus, *J. Appl. Phys. Lett.*, **81**, N13, 2403 (2002).
[CAS](#)
[Article](#)
[Google Scholar](#)
14. B.A. Tavger, V.Ya. Demihovskii, *UFN*, **96**, 61 (1968).
[CAS](#)



Journal of Electronic Materials

2012, Volume 41, Number 9, pag. 2313-2316

[Article](#)

[Google Scholar](#)

15. N.B. Brand, D.V. Gitsu, A.A. Nikolaeva, and Ya.G. Ponomarev, *Zh. Exp. Teor. Fiz.*, **72**, 2332 (1977) (*Sov. Phys. JETP*, **45** (6) 1977).

[Google Scholar](#)

16. D. Gitsu, L. Konopko, A. Nikolaeva and T. Huber, *J. App. Phys. Lett.*, **86**, 10210 (2005).

[Google Scholar](#)

17. V.S. Edelman, *Sov. Phys. JETP*, **64**, N5, 1734 (1973).

[CAS](#)

[Google Scholar](#)

18. E.P. Sineavskiy, V.G. Solovenko, A.A. Nikolaeva, L.A. Konopko, N.E. Huber, *J. of Thermoelectricity*, **3**, 51, (2007).

[Google Scholar](#)

19. D.A. Pshenai-Severin, Yu.I. Ravich, *FTP*, **36**, N8, 974 (2002).

[Google Scholar](#)

20. I.M. Lifshits, **38**, 5, 1569 (1960).

21. R. Khamidullin •E. Brusenskaya •L. Konopko • A. Nikolaeva •A. Tsurkan, *J Low Temp Phys*, **158**, 536 (2010).

[CAS](#)

[Article](#)

[Google Scholar](#)