



MRS Online Proceedings Library

2011, Volume 1350, Number 1, pag. 1010

Semimetal-Semiconductor Transitions in Semimetal Bismuth-Antimony Nanowires Induced by Size Quantization, Strain, and Magnetic Field

**Albina A. Nikolaeva, Leonid A. Konopko, Tito E. Huber,
Pavel P. Bodiu, Ivan A. Popov, Eugen F. Moloshnik**

<https://doi.org/10.1557/opl.2011.1164>

Abstract

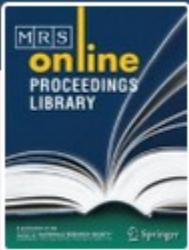
In this work, we study glass-coated single-crystal Bi₉₈Sb₀₂ wires obtained by liquid phase casting.

Semimetal Bi₉₈Sb₀₂ 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 || C₃ and H || C₂ 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*



MRS Online Proceedings Library

2011, Volume 1350, Number 1, pag. 1010

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. Anatychuk, *J. of Thermoelectrisity*, **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).

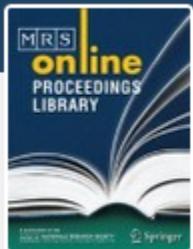
[CAS](#)

[Article](#)

[Google Scholar](#)

14. B.A. Tavger, V.Ya. Demikhovskii, *UFN*, **96**, 61 (1968).

[CAS](#)



MRS Online Proceedings Library

2011, Volume 1350, Number 1, pag. 1010

[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](#)