

One-dimensional transport in polymer nanowires

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The use of nano-structured conjugated polymers as components of nanoelectronics is the promising way of manufacturing high-density chips of low cost. Conjugated polymers could be synthesized in precisely controlled way to have nano-structures in many forms including molecular wires (fibers), whose conductivity greatly increased upon doping. Nanofibers made of polyacetylene (PA) are of particular interest because of the model chemical structure of this polymer, which consist of linear chains of CH units with alternating single and double bonds. That makes this polymer promising for one-dimensional (1D) nanotransport studies and nanodevice applications including nanofiber field-effect transistors (FETs). We report the results of transport studies for helical PA [1] fibers (diameter ≈ 100 nm) doped with iodine as well as the data analysis for other polymer fibers (diameter ≈ 15 -20 nm) to understand the transport features in such 1D conductors. We found that at $T = 30 - 300$ K the electrical conductance of the polymer fibers follows the power law $G \sim T^m$ with $m \approx 2 - 6$ depend on the fiber geometry. Current-voltage characteristics of such nanofibers are nonlinear and at low temperature follow the power law $I \sim V^n$ with $n \approx 2 - 3$. It means that both $G(T)$ and $I(V)$ show some features characteristic of 1D systems, namely Luttinger liquid or Wigner crystal. The relationship between these results and theories for tunneling into 1D systems is discussed. Recent results on conjugated polymer nano-devices are reviewed [2] and some suggestions on the future trends in conjugated polymers nanoelectronics is given.

[1] K. Akagi, G. Piao, S. Kaneko, K. Sakamaki, H. Shirakawa, M. Kyotani, *Science* 282, 1683 (1998).

[2] A. N. Aleshin, in *Future Trends in Microelectronics: The Nano, the Giga, the Ultra, and the Bio*, Ed. by S. Luryi, J. Xu, A. Zaslavsky, Wiley, 2003, in press.

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