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Electrical transport through poly(G)–poly(C) DNA molecules

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Abstract

We report the details of the direct electrical transport through 60 base pairs of poly(G)–poly(C) DNA molecules between two electrodes with nanometer spacings. An almost monotonic increase in the current is observed from the sample with the gap of 30 μm and with a DNA solution droplet. The I–V and the dI/dV–V measured from various samples with the electrode gap ranging from 20 to 100 nm at different conditions show reproducible clear staircases. The average gap value of the observed staircases is consistent with the energy gap obtained from a tight binding calculation.

Keywords: DNA; Molecule; Electrical transport; Voltage gap

Recently, the study of DNA molecules became an important topic in nano-science because of their potential applications to molecular electronic devices [1–3]. DNA molecules have several advantageous properties as a nano device material such as size controllability using the base combination and the possibility of self-assembly [4,5].

Many experimental and theoretical studies were devoted to understand the electrical transport properties of DNA molecules using various techniques. Super-conducting behavior was observed in 16-μm-long λ-DNA molecules [6]. Metallic behavior was observed from a few μm-long λ-DNA ropes [7]. Semiconducting behavior from the 10.4-nm-long DNA molecules was reported [8] and it was recently reported that the manipulation of the base combination changed the carrier type of DNAs [9]. We have reported direct electrical measurements through 60 base pairs of poly(G)–poly(C) DNA molecules (20.8 nm long) located in between two electrodes with a nanometer spacing [10]. In this paper, we present further details of the electrical transport through DNA molecules residing in various samples with different gap sizes and under different conditions.

Fig. 1 shows a schematic of the sample structure for measuring the transport through DNA

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