EXPLORING THE MAGNETICALLY INDUCED FIELD EFFECT IN CARBON NANOTUBE BASED DEVICES

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Remarkable modifications of the electronic structure due to the Aharonov-Bohm (AB) effect have been predicted for carbon nanotubes (CNTs) subjected to a parallel magnetic field [1]. In particular, an increasing magnetic flux through the cross-section of a nanotube leads to an opening of the gap at the Fermi energy in metallic CNTs, thus tuning the band structure of a CNT from a metal into a semiconductor. Here we report on the high magnetic field study of transport properties of gated small diameter (quasi)-metallic SWNTs. We show that initially metallic CNT devices operate as CNT field effect transistors under strong magnetic fields [2]. This effect results from the AB phenomena at the origin of a band gap opening in metallic nanotubes. Strong exponential magnetoresistance observed up to room temperature is the ultimate consequence of the linear increase of the band gap with a magnetic field. Finally, we show that intrinsic characteristics of a quasimetallic CNT, such as the helical symmetry, as well as the parameters of the Schottky barriers formed at the contacts, can be deduced from temperature dependent magnetoconductance measurements.

[1] H. Ajiki and T. Ando, *J. Phys. Soc. Jpn*. **62**, 1255 (1993).
[2] G. Fedorov, A. Tselev, D. Jiménez, S. Latil, N. G. Kalugin, P. Barbara, D. Smirnov, and S. Roche, *Nano Letters* **7**, 960 (2007)

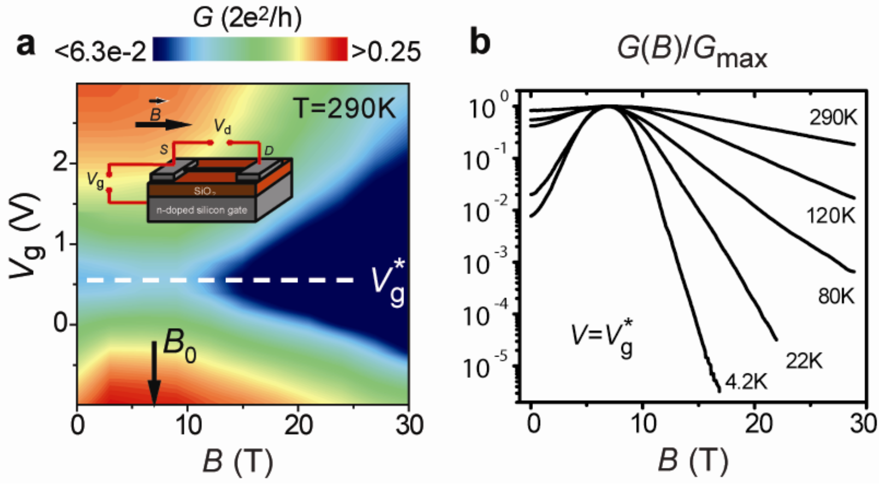

Figure 1. Magnetically induced field effect in carbon nanotube based devices. (a) Plot of the sample 1 conductance versus the gate voltage and the axial magnetic field. A dark arrow indicates the value of B_0, where the gap $\varepsilon_g(B)$ has a minimum. (b) Off-state magnetoconductance of sample 1. At B>10 T the $G(B)$ curves appear as straight lines in the log-vs-linear scale

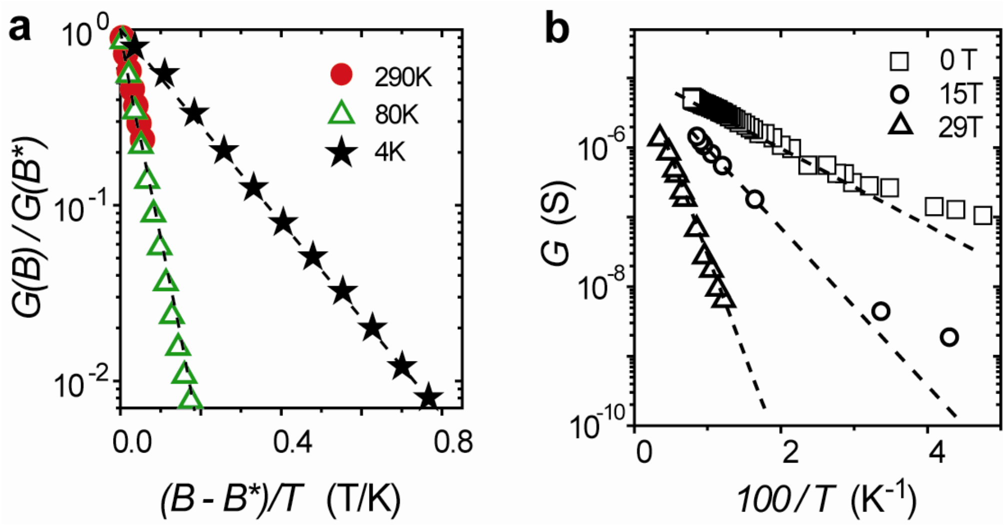

Figure 2. (a) Normalized off-state magnetoconductance $G(B)/G(B^*)$ of sample 1 as a function of the rescaled magnetic field $B' = (B - B^*)/T$, where B^* =12 T. (b) Arrhenius plots of the conductance of sample 1.

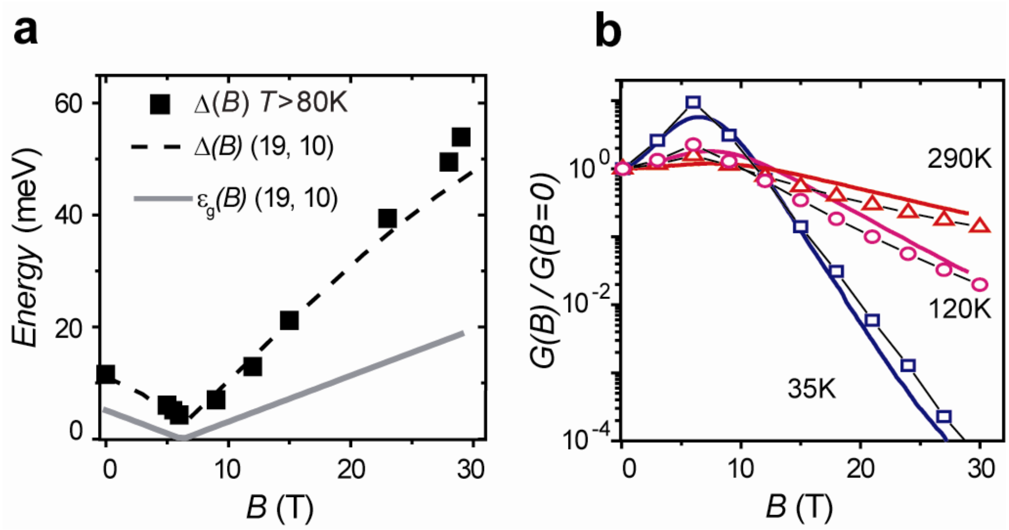

Figure 3. (a) Transport activation energies $\Delta(B)$ determined from the conductance Arrhenius plots (sample 1) and $\Delta(B)$ calculated for the (19,10) CNT. Gray line shows calculated ε_g(B) dependence. (b) Solid lines show simulation results for the (19,10) CNT. (b) Normalized off-state magnetoconductance of sample 1 compared to simulations for the (19,10) CNT.