Magnetotransport of Polyacetylene Nanofibers in High Magnetic and Electric Fields

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Introduction

In polyacetylene (PA), the simplest conducting polymer with degenerate ground state, solitons (charge with no spin for the charged solitons and charge neutral with spin 1/2 for the neutral solitons) are predicted to be formed. We show that the electric field dependent magnetoresistance (MR) of polyacetylene (PA) at low temperature.

Experimental

Single R-helical PA fibers with a cross section, typically 50 nm in height, 200 nm in width and a length up to ~10 μm, were deposited on top of 2 μm spacing platinum electrodes. The PA fibers were doped with iodine from vapor phase right before transport measurement. The MR of the iodine doped helical PA fibers up to H=35 T were measured using a resistive magnet at the NHMFL.

Results and Discussion

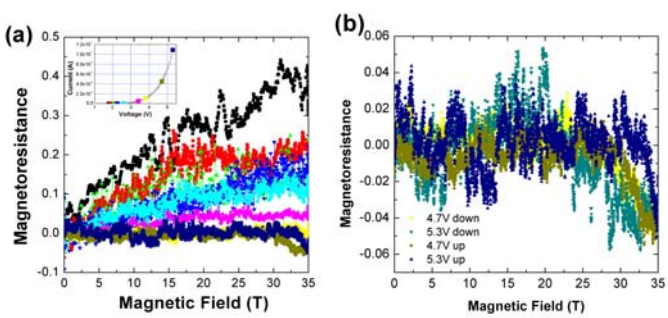

Fig. 1 (a) MR for R-helical PA Nanofiber, **(b)** PA Nanofiber MR in high electric Field

Fig.1 (a) presents the bias voltage dependent MR of R-helical PA nanofibers at low temperature, T = 1.2K. The positive MR decreases as bias voltage increases and becomes almost zero for V > 4.7V. At that time, the electric field on the PA fibers is about 2.4×10^4 V/cm. However, negative MR appears above 25T at high electric field in Fig. 1 (b).

The zero MR at high electric field ($E>2.4\times10^4$V/cm) for polycacetylene nanofibers at H<25 tesla is reconfirmed in this measurement. Furthermore, the MR becomes negative for H>25 tesla as Fig.1 b. It could be the result of interchain transfer of solitons at this high magnetic field. For more systematic investigation of the negative MR effect, we would need to measure the MR up to 45 tesla.

Conclusions

The zero MR of polyacetylene nanofibers at high electric field and H<25 tesla has been reconfirmed, which manifests the evidence of spinless charged soliton tunneling conduction in polyacetylene nanofibers. The negative MR at high electric field and H>25 tesla needs to be investigated more systematically with H=45 tesla hybrid magnet system.

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