Magnetotransport of Polymer Nanofibers in High Magnetic and Electric Fields

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Introduction

Polyacetylene is unique in that the lowest-energy charge excitations are predicted to be spinless charged solitons rather than electrons and holes. We show that the electric field dependent magnetoresistance (MR) of polyacetylene (PA) at low temperature. To compare this, we measured the MR of polyaniline (PANI) nanofibers.

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=30 T and the HCl doped PANI nanofibers up to H = 35 T were measured using a resistive magnet at the NHMFL.

Results and Discussion

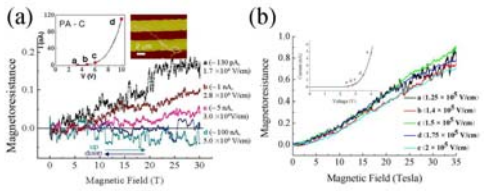

Figure 1(a) MR for R-helical PA nanofiber, (b) MR for PANI.

Fig.1 (a) presents the bias voltage dependent MR of R-helical PA nanofibers at low temperature, T = 1.5K. The positive MR decreases as bias voltage increases and becomes almost zero for V > 5V. At that time, the electric field on the PA fibers is about 5×10^4 V/cm. But, for PANI nanofibers, the large MR is not reduced as the electric field at low temperature as shown in Fig. 1 (b). It remains at the same large positive MR value at the high electric field, which is completely different from the electric field dependence of the PA nanofibers.

Conclusions

We have observed positive MR for both polymer nanofibers in low electric field and in high electric field, the MR for PA disappears and yet the MR for PANI remained high. The observed high MR of PANI fibers could be originated from the polaron (which has both spin and charge) tunneling. For PA nanofibers, the zero MR at high electric field is understood as due to the soliton (which has charge but no spin) tunneling in high electric field and low doping level.

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