PROTON NMR STUDY OF ELECTRON MOTION IN THE CONDUCTING POLYMER POLY-3-METHYL-THIOPHENE-PF_6

W.G. Clark, G. Gaidos (UCLA, Physics and Astronomy); A.P. Reyes, P. Kuhns, W. Moulton (NHMFL Tallahassee); R. Menon, K.P. Ramesh (IISc Physics, Bangalore, India)

Introduction

Electron motion in conducting polymers generates a fluctuating magnetic field that can contribute to the proton spin-lattice relaxation rate $1/T_1$ in these materials. By measuring $1/T_1$ over a wide range of frequency/field and temperature (T), one obtains the power spectra of these fluctuations for comparison with models of the corresponding electron transport. One complication is that orientational motion of localized electron spins can also contribute to $1/T_1$. Making the measurements over a wide range of field and temperature provides important input for separating these contributions.

Results and Discussion

Measurements of $1/T_1$ for protons were performed on 5 samples of conducting polymer films in applied magnetic fields (B_0) of 16.355T (0.695 GHz) and 23.38T (0.0994 GHz). Three of the samples studied were poly-3-methyl-thiophene (P3MET) doped with PF_6 ions to different levels. The remaining samples were poly-3-hexyl-thiophene (P3HT) doped with PF_6 and polyethylene-dioxythiophene doped with polystyrene sulfonic acid (PEDOT-PSS). The results for one of the P3MET samples (fully doped then dedoped for 4 min.) are shown in Fig. 1. There, it is seen that above about 20 K $1/T_1T$ depends only slightly on the NMR frequency, but that it decreases at a rate that is nearly inversely proportional to T. Below 10 K, $1/T_1T$ drops substantially starting at a higher T for the higher frequency. This behavior suggests a reduction of the contribution from localized moments at low T as they become highly polarized. [1].

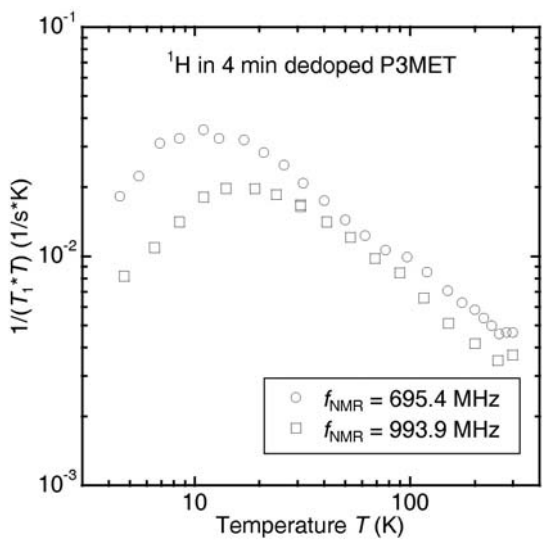

Fig. 1. Plot of $1/T_1T$ as a function of T for protons in a 4 min. dedoped sample of P3MET at B_0 = 16.355T (0.695 GHz) and 23.38T (0.0994 GHz).

Acknowledgements

The UCLA part of this work was supported by NSF Grants DMR-0334869 and INT-0225578 (WGC). Part of the work at the NHMFL was supported by a Visiting Scientist Award (WGC).

References

[1] Clark, W.G., *et al.*, Physical Phenomena at High Magnetic Fields, Z. Fisk, *et al*., eds. (World Scientific, Singapore, 1999) p. 233-6.