FREQUENCY DEPENDENT RELAXATION AND ^{39}K PULSED ENDOR OF Cr^{5+} IMPURITIES IN K_3NbO_8

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Introduction

The compound K_3NbO_8:Cr^{5+} has previously been suggested for use as a field standard for multi-frequency EPR applications, due to its narrow linewidth of about 0.2 mT over a large field and temperature range, while the significant deviation from the free-electron g-value avoids the overlap with EPR signals from organic radicals[1]. The narrow linewidth also suggest that the relaxation in this transition-metal system is quite slow and that hyperfine interactions with neighboring nuclear spins are small. As it has been suggested that this kind of transition metal systems could be used as electron-spin qubits in quantum computers, we embarked on a more detailed study of the hyperfine coupling and the T_1 and T_2 relaxation rates at a function of temperature and magnetic field. At the same time this is the first system to have been studied by pulsed Electron-Nuclear Double Resonance (ENDOR) in the high frequency pulsed EPR spectrometer that has recently come on-line.

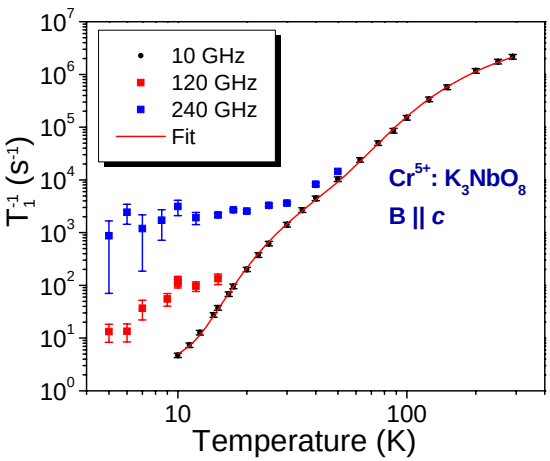

Figure 1 SLR of Cr^{5+} in K_3NbO_8

Experimental

Low-field (0.3 T) relaxation measurements were performed on the Bruker Elexsys 680 spectrometer, while 120 and 240 pulsed EPR-ENDOR measurements were performed on the home-built super-heterodyne quasi-optical spectrometer at the NHMFL[2]. The samples were single X-tals of approximately $0.2 \times 0.2 \times 0.3$ mm at 120 and 240 GHz, and of the order of $1 \times 1 \times 1$ mm at X-band.

Results and Discussion

Fig.1 shows the spin-lattice relaxation rate as a function of temperature at several frequencies. The low-frequency data can be fitted very well with a direct process (linear in T) and thermal excitation to 2 distinct higher lying states. At higher field the low temperature relaxation is much faster, as can be expected for the direct process. The low-temperature spin-spin relaxation rate is not found to be frequency dependent. It is mainly due to hyperfine interaction with the surrounding potassium spins. While at low fields the ENDOR is not directly measurable due to the small magnetic moment of the ^{39}K nucleus, at 240 GHz we measure a nice Mims-ENDOR spectrum shown in figure 2, which gives us both the hyperfine and quadrupolar couplings of the surrounding potassium spins.

Conclusions

We have measured very high frequency Mims-ENDOR of the potassium ions surrounding the CrO_8^{3-} ions in K_3NbO_8. The spin-lattice relaxation at low temperature is strongly field dependent and is found to be 3 orders of magnitude faster at 8.5 Tesla than at 0.3 Tesla.

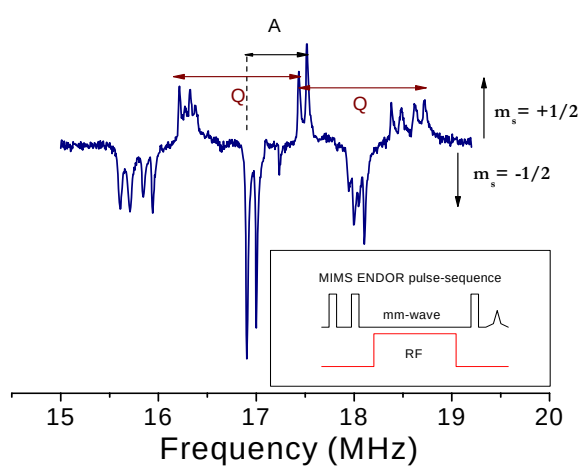

Figure 2 MIMS ENDOR at 240 GHz

Acknowledgements

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References

[1] Cage, B., *et al*., Anal. Chem, 71, 1951 (1999).
[2] van Tol, J., et al. Rev. Sci. Instrum. 76, 074102 (2005).