CW and Pulsed EPR Study of Spin Triangle Molecules $\{Cu_3(OH)\}$

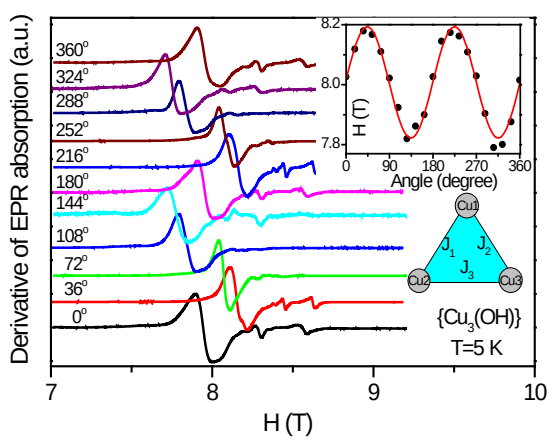
A.N. Ponomaryov, K.Y. Choi (Chung-Ang Univ., Korea); J. van Tol, A. Ozarowski (NHMFL); Z.H. Jang, S. Yoon (Kookmin Univ, Korea.); B.J. Suh (Catholic Univ., Korea)

Introduction and Experimental

In the last decades a considerable research interest has been focused on antiferromagnetically coupled spin triangles due to the pronounced effects of spin frustration and spin chirality at a nanoscale level. Extensive EPR studies of $Na_{12}[Cu_3(H_2O)_3\text{-}\alpha XW_9O_{33})_2]$ demonstrated that the spin triangle molecules provide a promising avenue for spin-based quantum gates. However, a spin memory time is limited to be T_2 = 1066 ns at 1.5 K [1]. For practical implementation, a spin decoherence time should be increased. This motivates us to examine another $\{Cu_3(OH)\}$ molecule, which forms a slightly distorted S = 1/2 triangular antiferromagnet.

To determine the magnetic parameters of a spin Hamiltonian, we performed angular dependence EPR measurements using the 240 GHz superheterodyne spectrometer located at NHMFL, in a temperature range of T=5 - 300 K. A spin decoherence time was measured by employing a Hahn echo pulse sequence using the same spectrometer in a pulse mode.

Results and Discussion



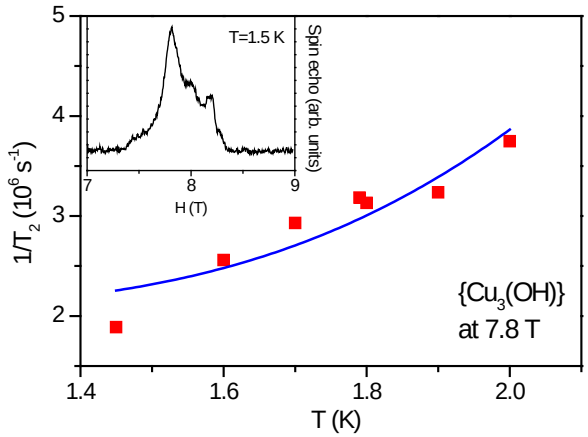


Figure 1. (Left panel) EPR spectra of $\{Cu_3(OH)\}$ single crystal measured at T=5 K as a function of an angle between a principal crystal axis and an external field. In the inset the full circles represent the main resonance position and the red solid line is a fit of the experimental data to a sine function. (**Figure 2**) Temperature dependence of a spin-spin relaxation rate, $1/T_2$ measured at H = 7.8 T. Inset: Integrated intensity of a spin echo signal of $\{Cu_3(OH)\}$ as a function of an external field recorded at T = 1.5 K.

CW EPR spectra of $\{Cu_3(OH)\}$ recorded at T = 5 K are presented in the left panel of **Figure 1** as a function of angle. We observe one intense peak and two weak peaks. The former is assigned to the transition between the two states of the S^T = 1/2 levels. The latter might be due to the fact that the studied sample contains a fraction of pieces with different orientations. Overall, the observed EPR resonance lines are compatible to the exchange coupling constants of J_1 = -48 K, J_2 = -44 K and J_3 = -40 K extracted from a simulation of magnetization.

The inset of **Figure 2** shows the field-swept EPR spectrum recorded by integrating a spin-echo signal at 1.5 K. Similar to the cw spectrum, we identify the main peak together with two additional peaks. The spin coherence time is measured to be T_2 = 529 ns at 1.45 K, which is shorter than that of $Na_{12}[Cu_3(H_2O)_3\text{-}\alpha XW_9O_{33})_2]$ [1]. The temperature dependence of the spin-spin relaxation rate is described by a spin flip-flop process. Further studies are planned to pin down a key parameter of limiting a T_2 time in spin triangle geometry.

References

[1] Choi, K.-Y., *et al.*, Phys. Rev. Lett., **108**, 067206 (2012).