ON THE USE OF TUNABLE-FREQUENCY ESR IN THE STUDY OF THE H VS. T PHASE DIAGRAMS OF MULTIPLE METAMAGNETIC PHASE TRANSITION 1D MAGNETS: STUDIES OF 1D CHAINS BASED ON EXOBIDENTATE LIGANDS IN M(1,4 – PYRAZINE)CL_2 COMPLEXES(M= Divalent Fe, Co, Ni)

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Introduction

We have initiated a program of research on the tunable-frequency, high-field ESR of 1D chain magnetic systems derived from the exobidentate ligand (1,4-pyrazine). The overall goal of this research is to systematically extend the tunable-frequency/high-field capability of the NHMFL to the antiferromagnetic resonances of complex low dimensionality transition metal magnets capable of exhibiting multiple relatively closely spaced, field induced phase transitions in their H versus T phase diagrams. These results will be correlated with concurrent detailed investigations of magnetic structure based on the temperature dependence of zero and applied field powder neutron diffraction for polycrystalline and single crystal samples.

Experimental

Classical ac and dc magnetization studies were conducted at Northeastern University. using a commercially available SQUID magnetometer (Quantum Design MPMS system). The tunable-frequency/high-field/ESR experiments were performed at the NHMFL using the mm and sub-mm spectroscopy facility and the resistive Keck magnet.

Results and Discussion

Some typical magnetic results for the 1D chain Ni(1,4-pyrazine)Cl_2 are shown below where two metamagnetic transitions are evident in the isothermal (1.8 K) dc magnetization (Figure 1) below 2.5 T. These are also reflected in the ESR spectrum (Figure 2) as two sharp non-resonant features A and B corresponding to an increase or decrease of sub-THz transmission through the powdered sample. The behavior of these features exhibits strong hysteresis depending on the direction of field sweep consistent with first order (metamagnetic) behavior. In addition, EPR transitions C, D, E within the field-induced paramagnetic phase of the solid are also detected in the high-field phase of the spectrum. These are characteristic of a powder pattern reflecting the local single-ion anisotropy of spin triplet ground state Ni^{2+}.

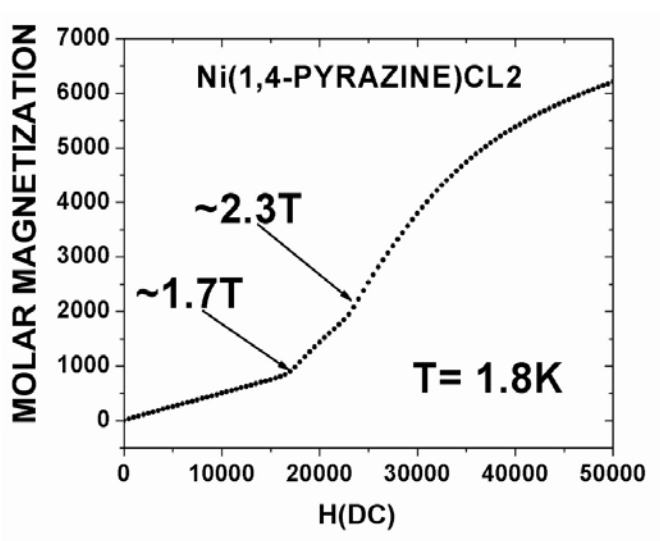

Figure 1. Dc magnetization of Ni(pyz)Cl_2 at 1.8 K.

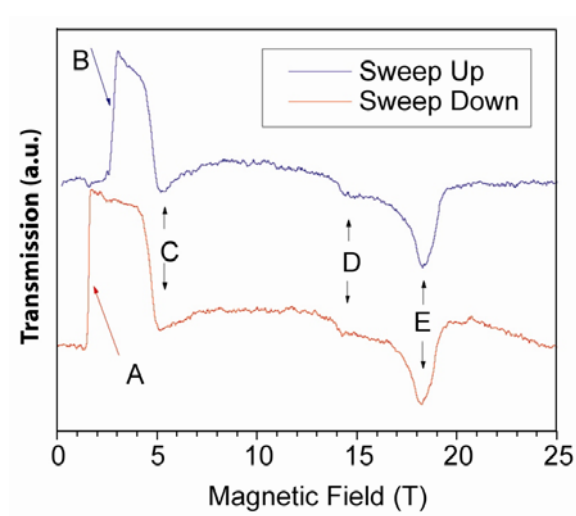

Figure 2. ESR spectrum of Ni(pyz)Cl_2 at 4.2 K and 424 GHz.