Characterization of a Natural Mineral

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Introduction

Azurite is a natural mineral with chemical structure $Cu_3(OH_2)(CO_3)_2$ proposed as a model compound for the 1D distorted diamond chain [1]. The magnetic behavior of this compound reflects the existence of both monomers and dimers of S = 1/2 Cu. A magnetization plateau at 1/3 of the saturation magnetization is observed in M vs H measurements due to the alignment of the monomers with the field. Recently, we measured M *vs.* H on Azurite in pulsed magnetic fields at NHMFL-LANL for the field applied along all three crystallographic axis *a*, *b* and *c*. We found that the very low temperature magnetization data disagreed with previous DC-field magnetostriction data near the critical field at which the 1/3 plateau starts for (H //a) and (H //b). Assuming that discrepancy could originate from the steep dB/dt in the pulsed field measurements (magneto-caloric effect for instance), we carried out the DC field magnetization measurements in order to check this assumption and also to generate M vs. H curves for (H //a) and (H //c) for comparison with the recently measured thermal expansion curves below 110 K (NHMFL Research Report #2008-238).
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Experimental

We have measured magnetization on Azurite using the VSM option of the 14 T PPMS for magnetic fields applied along the *a* and *c* crystallographic axis sweeping the field up to 14 T at fixed temperature and sweeping temperature from 100 K down to 1.8 K at fixed field.

Results and Conclusion

We show in the left panel of Figure 1 the derivative of the magnetization as a function of applied field for (H // a) at 1.75 K. A double peak structure is observed. The maximum around 2.1 T is also observable in magnetostriction measurements only for (H // a) and corresponds to the spin-flop transition. The second maximum at 11.5 T marks the entrance into the 1/3 plateau. Both results are in very good agreement with the DC field magnetostriction measurements. Measurement for (H//c) of M *vs.* T in zero field is shown in the right panel of Figure 1. As the temperature is lowered, we observe a shoulder structure around 20 K. This is in agreement with previous susceptibility measurements [1] and would correspond to the formation of the dimers in the a-c plane. As the temperature is further lowered, we observe a maximum around 4 K associated with short range order correlations between monomers. The susceptibility curves are very similar to the thermal expansion curves.

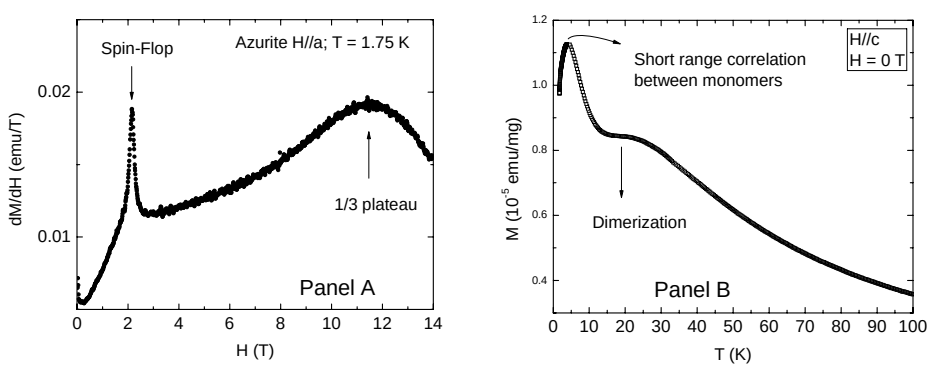

Figure 1 – Derivative dM/dH *vs.* H for (H // a) (left panel) and M *vs* T for (H // c) zero field (Panel B).

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References
[1] Kikuchi, H., *et al*. Physical Review Letters, **94**, 227201, (2005).