High-Field Multiferroic Phase Diagram of Ni_3TeO_6

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Introduction

Ni_3TeO_6 presents a collinear antiferromagnetic ground state [1] that sets in at T_C = 52K, which is unusual for a multiferroic. It also displays non- hysteretic spin flop-like transitions at 9T and 50T [2]. The non-centrosymmetric crystal structure supports a net electric polarization that is strongly coupled to the magnetization and reflects in the crystal lattice.

Experimental

Using a recently developed FBG-based optical technique for pulsed magnets we measured the thermal expansion and magnetostriction in a 65 T capacitor-driven short pulse magnet in a broad temperature range to determine the (H,T) phase diagram.

Results

Fig. 1 shows the thermal expansion as μStrain ($10^{-6}\Delta L/L$), as well as the coefficient of linear thermal expansion (α), vs temperature in the proximity of the 51.97K AFM transition, the magnetostriction as μStrain vs magnetic field, and the constructed (T,H) phase diagram. Besides the 9 T transition, we find a similar second phase transition at 52 T that also involves a lattice expansion.

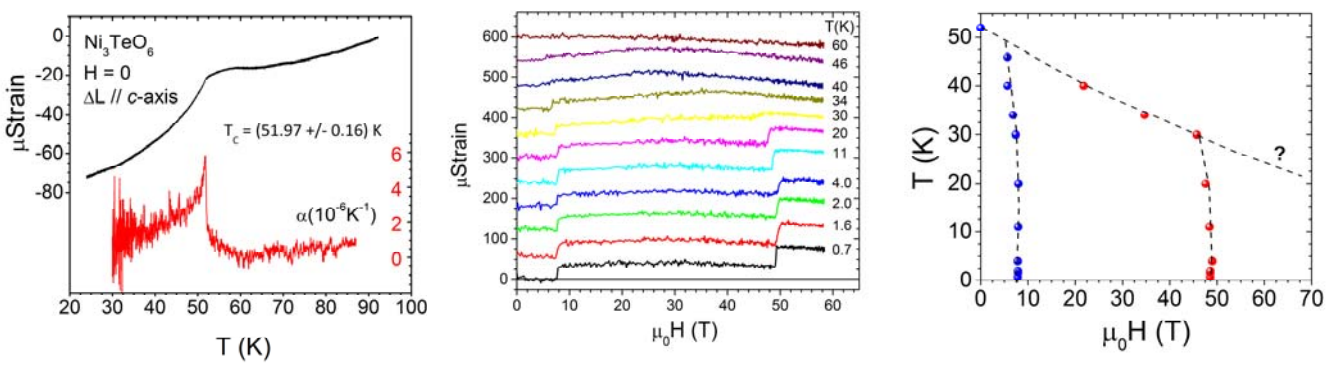

Fig. 1 Strain vs temperature, and strain vs magnetic field in pulsed magnetic fields are used to construct the (T,H) phase diagram for Ni_3TeO_6. The zero field AFM transition at 51.97 K, is apparently suppressed in two steps when magnetic fields are applied, but not saturation has been observed in its properties to 92T. The question mark in the (T,H) phase diagram refers to the possible extension of the AFM phase to very high magnetic fields.

Conclusions

These results require at least two, and probably three Ni^{2+} spins to be in the S = 1 state. Monte Carlo simulations in progress by Sergei Artyukhin and David Vanderbilt at Rutgers suggest that the two closest-neighbor Ni spins flop together, and a third Ni spin flops separately. Further calculations are in progress to determine what magnetic exchange and anisotropy terms in the Hamiltonian can reproduce the observed phase diagram.

Acknowledgements

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References

[1] I. Zivkovic *et al*, J. Phys.: Condens. Matter 22, 056002 (2010) [2] Y. S. Oh, Sergey Artyukhin, Jun Jie Yang, Vivien Zapf, Jae Wook Kim, David Vanderbilt, and Sang-Wook Cheong, to appear in Nature Comm. 2014