Magnetocapacitance as a Sensitive Probe of Magnetostructural Changes in $NiCr_2O_4$

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Introduction

Materials that exhibit magnetodielectric coupling enable the control of magnetic and electric polarization by either an electric or a magnetic field thus facilitating the design of higher density memory devices with increased flexibility for reading and writing information. As a result, magnetodielectric materials continue to be extensively studied[1]and in this report, we present detailed temperature- and field-dependent studies of the dielectric and magnetic properties of the multiferroic $NiCr_2O_4$ revealing an unobserved dielectric anomaly at 20 K and presenting the first high field measurements of this ferrimagnetic spinel.

Experimental

Polycrystalline samples of $NiCr_2O_4$ were prepared by solid-state preparation methods and studied using field- and temperature-dependent magnetization and dielectric measurements. High field magnetization was measured using an extraction magnetometer in a capacitor-bank-driven 65 Tesla pulsed-field magnet at the National High Magnetic Field Laboratory Pulsed-Field Facility at Los Alamos National Laboratory.[2]

Results and Discussion

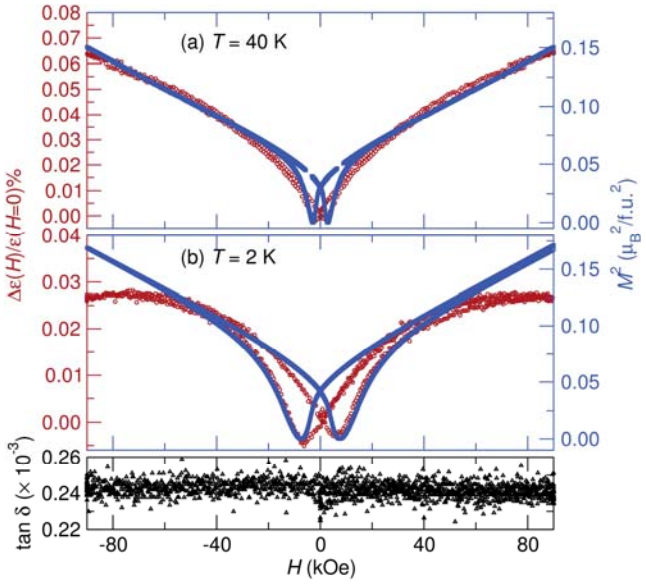

Figure 1. Field-dependent changes in the dielectric constant of $NiCr_2O_4$ linearly correlate with trends in the field-dependent squared magnetization at low fields**.**

Temperature-dependent dielectric measurements of the multiferroic spinel $NiCr_2O_4$[3,4] show that dielectric anomalies occur concurrently with changes in magnetic structure at 60 K and 30 K. We observe an unreported dielectric anomaly at 20 K which corresponds to the completion of spin and structural ordering demonstrating the sensitivity of dielectric measurements to magnetostructural changes in $NiCr_2O_4$. The changes in the field-dependent squared magnetization and field-dependent dielectric permittivity of $NiCr_2O_4$ are linearly correlated as shown in Figure. 1 and as described by Ginzburg-Landau theory. This linear correlation suggests that spin-spin interactions are the mechanism for magnetodielectric coupling in $NiCr_2O_4$. We also present the first high field magnetization measurements of $NiCr_2O_4$ which show a linearly increasing magnetization with field even at 4 K and 60 T.

Conclusions

We have shown that dielectric measurements are a sensitive probe of magnetodielectric coupling in $NiCr_2O_4$. We also show that the Ginzburg-Landau theory describes magnetodielectric coupling in $NiCr_2O_4$. This work will appear in *Phys. Rev. B*.[5]

Acknowledgements

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References

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