Giant Magnetic Hysteresis in Sr_3NiIrO_6

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Introduction

Sr_3NiIrO_6 single crystals were shown by us last year to have 40 T coercive magnetic field at 4 K, which is the highest coercive magnetic field at cryogenic temperatures to our knowledge [1]. This year we have completed the work with measurements on more and larger single crystals that allow us to calibrate the magnetization and determine sample-dependence. A separate report on sweep-rate dependence will also be submitted.

Experimental

We measured extraction magnetometry in a capacitor-driven short-pulse magnet up to 65 T in single crystals grown from both stoichiometric and Ni-rich flux, and calibrated against Vibrating Sample Magnetometry (VSM) data in a PPMS to 13 T.

Results

Fig. 1a shows 65 T short-pulse magnetization data taken in a Ni-rich off-stoichiometric sample. The switched moment is just under 1 μ_B/f.u. We find that this and other off-stoichiometric samples and those with irregular growth patterns have the highest and most robust coercive fields exceeding 40 Tesla. Fig. 1b on the other hand shows 65 T short-pulse magnetization data taken in a stoichiometric single crystal with very clean faces. Here a lower coercive field is seen between 30 and 40 Tesla, and relaxation behavior is observed on the down sweep.

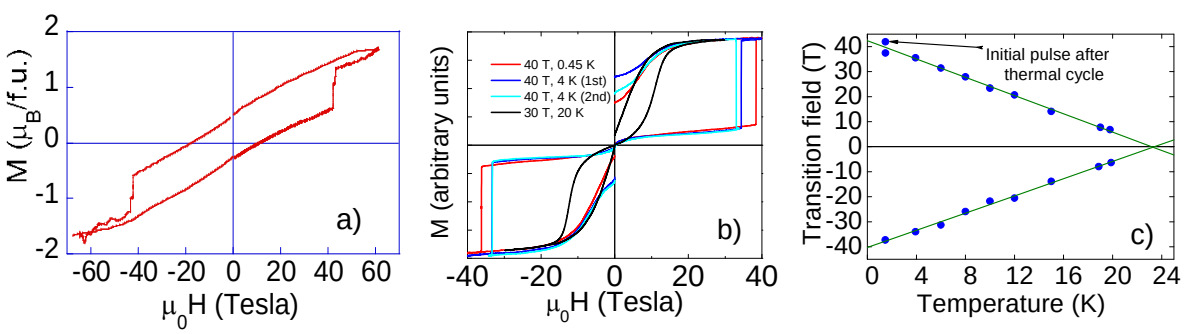

Figure 1 a) Magnetization at T = 4 K of a single crystalline $Sr_3Ni_{2-x}Ir_xO_6$ of grown from a Ni-rich batch with x = 0.95, measured in a short pulse magnet and calibrated against VSM data up to 13 T. **b)** A clean stoichiometric crystal measured in the same pulsed magnet showing relaxation behavior. **c**) Transition field vs. temperature for the sample in b).

Conclusions

We find a very high coercive field in Sr_3NiIrO_6 that is stabilized by off-stoichiometry and impurities, possibly due order-by-disorder in this frustrated system, or pinning of magnetic domains. Band structure calculations show that the spatially extended 5d Ir^{4+} orbitals directly overlap with the 3d Ni^{2+} orbitals, in addition to the intervening oxygen 2p orbitals. This produces very large single-ion anisotropy and orbital moments on the Ni2+ ion [2].

Acknowledgements

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References

[1] C. Topping, et al, "Giant magnetic hysteresis in Sr_3NiIrO_6," NHMFL Annual report, 2012.
[2] G. R. Zhang et al, J. Appl. Phys 107, 09E120 (2010); S. Sarkar et al, Phys. Rev. B 82, 235122 (2010)