Focused Ion Beam Lithography for Torque Magnetometry Measurements

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Introduction

The focused ion beam (FIB), commonly used in the semiconductor industry for imaging, deposition, and ablation of materials, can also be used for precision cutting. Recently, FIB was used to significantly reduce the size of a single crystal for cantilever torque magnetometry measurements. Cantilever magnetometers can detect a magnetic moment, $m=10^{-10}$ Am^2 at 1 T making them roughly three orders of magnitude more sensitive than the best commercial SQUID magnetometers. This technique is also particularly attractive for pulsed magnetic field measurements because small cantilevers have a fast response time in transient fields. However, when the magnetic anisotropy of a sample is very large, the torque generated by the sample often has the potential to the break the lever during a magnetic field pulse.

Experimental

Li_2IrO_3 experiences an order of magnitude anisotropy with field orientation at low temperature resulting in a very large torque signal. All previous attempts to measure the smallest Li_2IrO_3 single crystals available in high magnetic fields have resulted in broken levers. After utilizing the FIB to reduce the size of the smallest crystal by a factor of 5 (Figure 1), and by depositing platinum to hold the crystal in place, a complete angle dependence of the torque was performed (Figure 2).

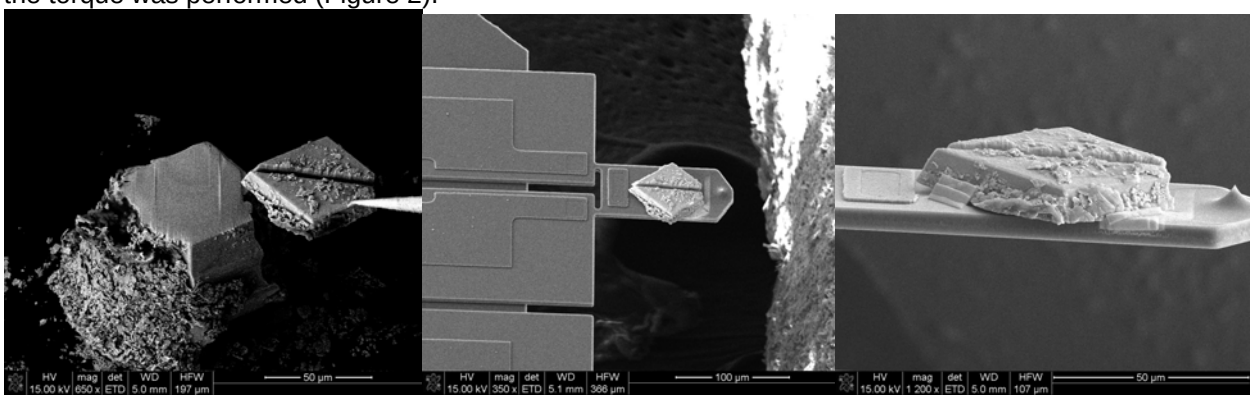

Fig.1. Left panel: small Li_2IrO_3 single crystal showing the a-b face and a slice cut off using the FIB. Middle panel: slice of crystal has been attached to the micro-cantilever. Right panel: close-up of the crystal on the cantilever.

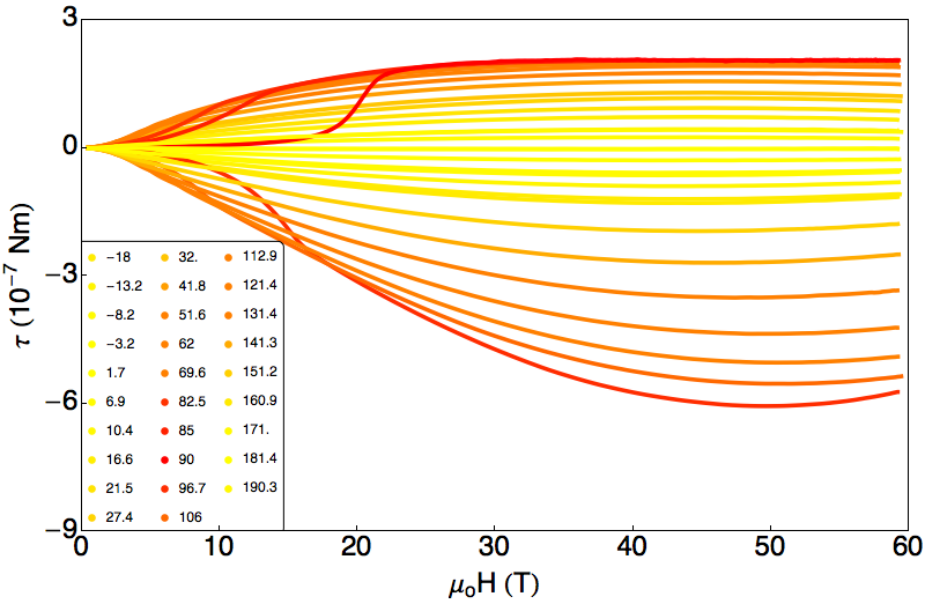

Fig 2. Complete angle dependence of torque of Li_2IrO_3 at 1.75K with the field rotated in the b-c plane.

Acknowledgements

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References

[1] Modic, K.A., *et al.*, Nat Commun, 5: 4203, 2014. Doi:10.1038/ncomms5203