Magnetism of exfoliated 2D chromium chloride $CrCl_3$

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The development of layered 2D magnetic materials is enabling the design of a new generation of spintronic devices such as magnetic tunnel junctions based on heterojunctions with graphene, for efficient sensing, computing and data storage.[1] Recently, ferromagnetic order in single and few layers of chromium iodide (CrI_3) prompted further studies of 2D flakes of chromium halide compounds (CrX_3).[2,3]
With the aim to understand the effect of decreasing thickness of $CrCl_3$ crystals on key magnetic properties such as anisotropy, we present a study of exfoliated $CrCl_3$, a member of the CrX_3 family, combining low temperature magnetic characterizations of the flakes obtained with spatially resolved Magnetic Force Microscopy (MFM) and surface sensitive synchrotron X-ray Circular Magnetic Dichroism (XMCD). We compared the obtained results with the ones attained with bulk crystal by SQUID magnetometry. The CrX_3 crystals were mechanically exfoliated with an adhesive tape and attached on silicon wafers by van der Waals forces, obtaining flakes with thicknesses between 5 and 40 nm. We observe clear differences in the shape of the magnetic saturation curves of the thin flakes compared to the bulk, related to an alteration of the magnetic anisotropy dependent on the $CrCl_3$ thickness. This result highlights the importance of local magnetic probes for the characterization of 2D magnetic flakes.

References

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[3] M. A. McGuire, G. Clark, KC Santosh, W. M. Chance, G. E. Jellison Jr., V. R. Cooper, X. Xu, B. C. Sales, Physical Review Materials, 1 (2017), 014001

Figures

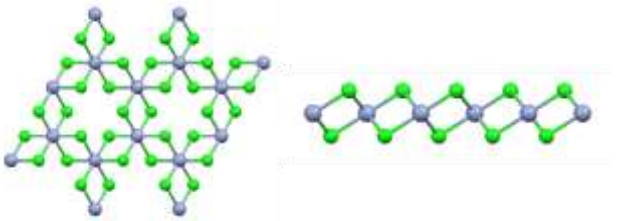

Figure 1: Top (left) and side view (right) of the crystal structure of a layer of $CrCl_3$ (Cr grey, Cl green)

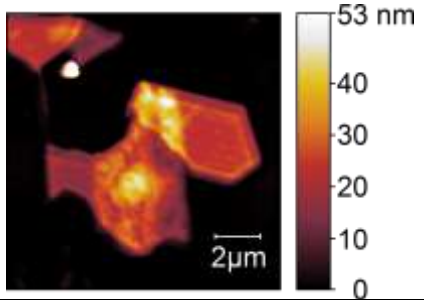

Figure 2: Topography of flakes of $CrCl_3$ measured during MFM at 14K

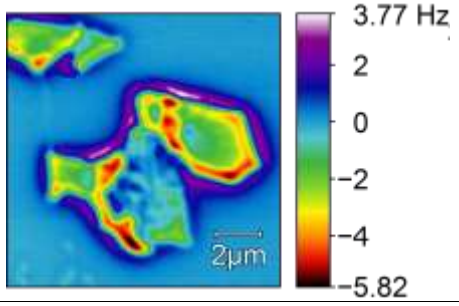

Figure 3: MFM image at 3 Tesla and 14 K of the $CrCl_3$ flakes shown in Figure 2