Magnetism of exfoliated 2D chromium chloride CrCl$_3$

Michele Serri$^1$
Lorenzo Poggini$^2$, Giulia Serrano$^2$, Giuseppe Cucinotta$^2$, Antonio Politano$^1$, Judyta Strychalska-Nowak$^3$, Tomasz Klimczuk$^3$, Luca Ottaviano$^4$, Matteo Mannini$^2$, Roberta Sessoli$^2$, Francesco Bonaccorso$^1$, Vittorio Pellegrini$^1$

$^1$Istituto Italiano di Tecnologia – Graphene Labs, via Morego 30, 16163 Genova, Italy
$^2$Università degli studi di Firenze, Chemistry Department “U.Schiff”, Via della Lastruccia 3-13, 50019 Sesto Fiorentino, Italy
$^3$Gdansk University of Technology, Department of Solid State Physics, 80-233 Gdansk, Poland
$^4$Università dell’Aquila, Dipartimento di Scienze Fisiche e Chimiche (DSFC), Via Vetoio 10, I-67100 L’Aquila, Italy
michele.serri@iit.it

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

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