Atomic Imaging of 2D Transition Metal Diiodides

Katarzyna Salamon
Wendong Wang, Gareth R. Tainton, Nickolas J. Clark, James G. McHugh, Xue Li, Sam Sullivan-Allsop, David G. Hopkinson, Oldrich Cicvárek, Francisco Selles, Rui Zhang, Joshua D. Swindell, Alex Summerfield, David J. Lewis, Vladimir I. Fal'ko, Zdeněk Sofer, Sarah J. Haigh, Roman Gorbachev
The University of Manchester, National Graphene Institute,
Oxford Rd, M13 9PL, Manchester, United Kingdom
Katarzyna.salamon@manchester.ac.uk

Abstract

Transition metal diiodides such as FeI_2, NiI_2, and CoI_2 are an emerging class of 2D magnets exhibiting rich and diverse magnetic behaviour, but their study at the monolayer limit has been severely hindered by fabrication challenges due to their air-sensitivity. Here, we introduce a polymer-free method for clean, rapid, and high-yield assembly of hermetically encapsulated suspended samples of air-sensitive monolayers [1]. Applied to diiodides, it enables atomic resolution characterization of thin samples down to the monolayer limit using transmission electron microscopy. Our imaging, combined with complementary first-principles calculations, reveals an unusually small energy barrier between alternate stable stacking polytypes in few-layer films, enabling extrinsic control of the stacking phase. We also observe stable isolated iodine vacancies that do not aggregate to form extended structures and identify and verify the stability of the various edge configurations of thin samples. These results establish the structural characteristics of these materials in the thin limit and more broadly demonstrate the utility of our transfer platform for creating atomically clean suspended van der Waals heterostructures.

References

[1] Wang W., Clark N. et al, Nature Electronics, 6, 981-990 (2023).

Figures

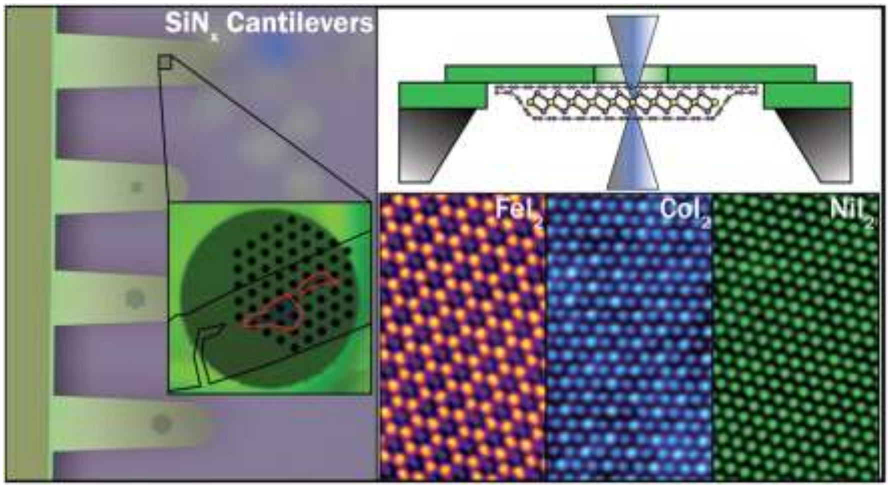

Figure 1: Left: Optical image of as-fabricated holey SiN_x cantilevers with different dimensions and hole arrangements. Inset shows magnified region with the suspended sample. Top right: Schematic of the cross section of graphene-encapsulated monolayer FeI_2 on the SiN_x TEM grid. Bottom right: HAADF STEM observations of atomically thin MI_2 crystals.