## Kinetic *In-situ* Synthesis (KISS) technique of large-area 2D materials exfoliation

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Two-dimensional (2D) materials provide an extremely rich platform to investigate novel quantum phenomena and to design nanostructures with desired functionalities [1]. Some of the key techniques employed in studies of 2D materials, such as photoemission spectroscopy, have stringent requirements for the quality, sample size and cleanliness of the surface. Fulfilling these conditions using a standard mechanical exfoliation in a glove box is often problematic.

Here, we present a novel method for in situ exfoliation of 2D materials performed directly in ultra-high vacuum, which yields large flakes of excellent crystallinity and purity [2]. In our experiments, multiple semiconducting and metallic transition metal dichalcogenides were exfoliated onto Au, Ag and Ge substrates, showing the versatility of the technique, and characterised by angle resolved photoemission spectroscopy.

Importantly, the proposed method is straightforward, simple, and does not require any specialised equipment. This technique is ideally suited for the electronic structure research of air-sensitive 2D materials since the sample preparation process happens entirely in ultra-high vacuum.



Fig. 1. An example of KISS exfoliated flake of WS2 on Ag(111). a) Optical microscopy image and b) bandstructure

around  $\Gamma$  (left) and K point (right)..

[1] M. Zheng, Y. Xiao, J. Liu, K. Yang and L. Fu, Exploring Two-Dimensional Materials toward the Next-Generation Circuits: From Monomer Design to Assembly Control Chemical Reviews **118**, 2018.
[2] A. Grubišić-Č abo, M. Michiardi, C.E. Sanders, M. Bianchi, D. Curcio, D. Phuyal, M.H. Berntsen, Q.Guo and M. Dendzik, In-situ exfoliation method of large-area 2D materials, Advanced Science, In press, doi: 10.1002/advs.202301243, 2023