Ultra-High Vacuum Heterostructure Fabrication for Environmentally Sensitive 2D Materials

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Abstract

While the 2D materials library has been rapidly expanding from graphene to include materials such as hexagonal boron nitride (hBN), transition metal dichalcogenides (TMDC's) and many more, magnetic materials are a relatively recent addition [1][2]. Materials such as $Cr_2Ge_2Te_6$ have been shown to be ferromagnetic down to the few layer limit. However, detailed investigation into the crystallographic and electronic properties of such materials, especially of monolayer samples, has been limited due to the difficulty of fabricating clean monolayer samples due to their degradation in ambient conditions.

This work presents novel techniques for the fabrication of 2D heterostructures in ultra-high vacuum (UHV) conditions, using a polymer free transfer technique [3] The full fabrication process, including the exfoliation of materials is carried out in the UHV environment. The benefits of the technique are demonstrated through the fabrication of several samples of materials including $Cr_2Ge_2Te_6$ for ARPES measurements. The results show that UHV fabrication produces clean, high-quality devices showcasing its advantages in the fabrication of samples from such highly sensitive materials.

References

[1] Gong, Cheng, et al. "Discovery of intrinsic ferromagnetism in two-dimensional van der Waals crystals." Nature 546.7657 (2017): 265-269.
[2] Huang, B. et al. "Layer-dependent ferromagnetism in a van der Waals crystal down to the monolayer limit." Nature 546, (2017): 270-273.
[3] Wang, W. "Polymer-free assembly of ultraclean van der Waals heterostructures." Nat Rev Phys 4, 504 (2022).

Figures

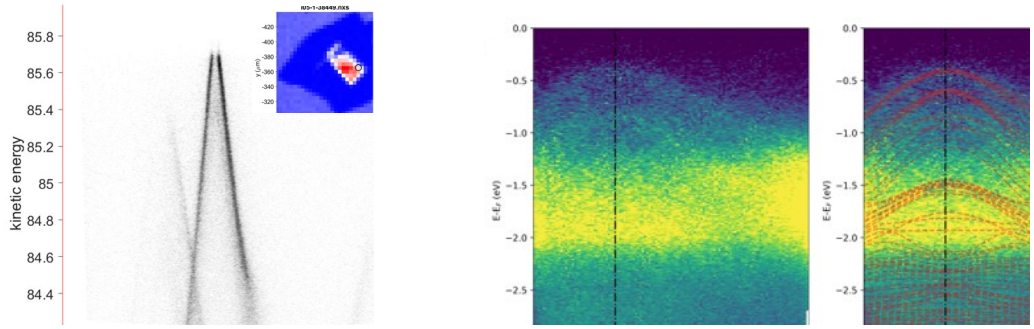

Figure 1: Angle resolved photo emission spectroscopy results for **a)** a graphene sample produced in UHV **inset**: the sample map showing the measurement location and **b)** a $Cr_2Ge_2Te_6$ sample with the calculated band structure overlayed on the right image.