THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

UMF
University Research Facility in
Materials Characterization and
Device Fabrication
材料與器件中心實驗室

UMF Equipment – Spectra 300

Double Aberration Correctors Scanning Transmission Electron Microscopy

BF&DF, SAED, HREM image, HAADF image, IDPC, 4D-STEM, EDS, EELS

The Spectra 300 STEM is the highest resolution imaging and spectroscopic platform. By synchronizing new ultra-high resolution (X-FEG UltiMono source, Image and 5th order probe aberration correction, single electron sensitive STEM detection, wide-gap pole piece and sensitive energy dispersive X-ray (EDX) detectors through advanced software and automation modules, the Spectra 300 (S)TEM makes accessing the highest-resolution atomic-scale information more efficient, easy, and repeatable. Various analytical instruments such as EDX, EMPAD (electron microscope pixel array detector) for 4D-STEM, segment BF/DF detectors for IDPC (Integrated differential phase contrast), OneView CMOS (Complementary metal-oxide-semiconductor) camera for image and GIF continuum K3 system for EELS (electron energy loss spectrometer) are integrated.

Specifications:

- **Best atomic characterization.** Optimized electron optical performance and ultra-sensitive detection enables the best combination of atomic imaging and analysis in 2D and 3D.
- **Most repeatable data.** Sophisticated software automation routines such as OptiSTEM+ and OptiMono+ optimize the system to its peak performance, resulting in more repeatable and quantifiable data.
- **Optimum EDS performance.** Guaranteed by a portfolio of symmetric detector geometries, which contributes to unique quantification capability, in combination with an ultra-high brightness X-CFEG to provide rapid EDS mapping across the widest range of materials.
- **Best in situ and dynamic research.** Fast cameras, chemical detectors, smart software, and wide gap S-TWIN lens enable in situ data acquisition with no compromise on resolution and analytical capabilities.
- **Best environmental stability.** The redesigned enclosure and ultra-stable Spectra 300 (S)TEM base with passive and (optional) active vibration isolation minimize external environmental influences and ensure the highest quality data from long-term and short-term experiments.
- **Widest range of materials science research in one platform.** The best combination of optics, ultra-sensitive detection, and wide-gap pole piece, ensures that even the lightest, most sensitive materials can be characterized at the atomic scale.

Please refer to https://www.thermofisher.com/hk/en/home/electron-microscopy/products/transmission-electron-microscopes/spectra-300-tem.html for further details of the system.
For training arrangement, please log on URFMS website for further details of upcoming training session.
For any enquiry, please contact Dr. Wei Lu (Tel: 34002077; Email: wei.lu@polyu.edu.hk).

Application:

Science 2022 Vol:376 Issue: 6596 Page 973-978
DOI: 10.1126/science.abm5734

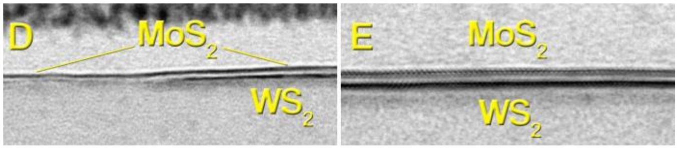

Fig. S4. BF-STEM images corresponding with the HAADF-STEM images from Fig. 1.

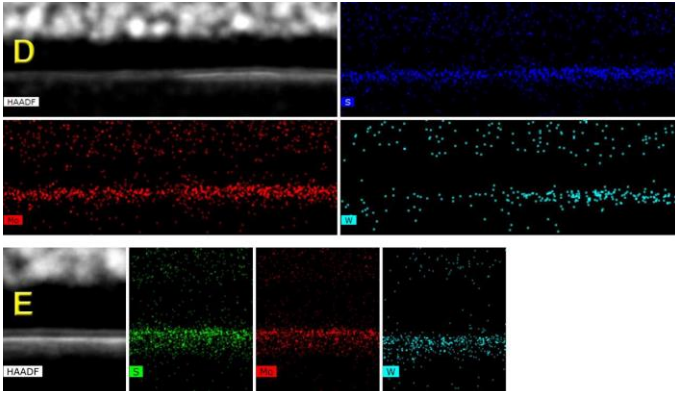

Fig. S5. EDS analysis of the cross-section STEM measurements from Fig. 1. The labels (**D)** and (**E**) are in reference to the locations indicated in Fig. 1C. For each location, the HAADF-STEM image, as well as the EDS mappings for S, Mo and W atoms are shown.

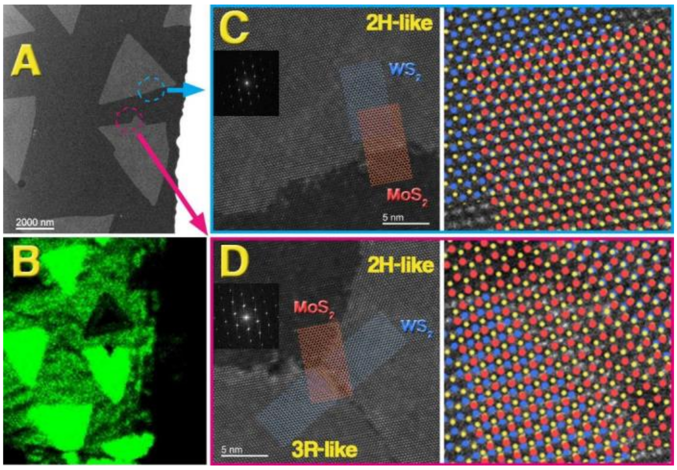

Fig. S8. STEM geometry analysis of the heterobilayer triangles. (**A**) SEM image of two triangles used for top-down HAADF-STEM. The triangles look similar apart from their orientation. The blue and magenta circles indicate where the STEM images were taken from. (**B**) SHG map of the triangles. The dark SHG emission of the top triangle indicates 2H-like stacking, the bottom triangle is mostly very bright and therefore 3R-like but it has a dark corner at the top which is 2H-like. This means that triangle is really two opposite triangles fused together. (**C, D**) HAADF-STEM images of the edges of the 2H-like (C) and 3R-like (D) triangle. Heterobilayer areas appear especially bright due to the heavy tungsten atoms. We can see the domain boundary between the large 3R-like and small 2H-like parts of the bottom triangle. The insets show the Fast Fourier Transform (FFT) of the respective STEM images. In each STEM image a model for MoS_2 and WS_2 monolayers have been overlaid, where Mo atoms are red, W atoms are blue and S atom pairs are yellow. The area where these models intersect (enlarged pictures on the right side) reveals the stacking types.