Studying Surfaces and Interfaces in Transition Metal Dichalcogenides with Advanced Transmission Electron Microscopy

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Surfaces and interfaces are key to the performance of 2D materials heterostructures including for controlling optoelectronic phenomena [1], enhancing electron interactions in moire superlattices [2], or for studing transport with nanofluidic devices [3]. Progress crucially depends on knowledge of the local atomic structure, which in many cases can only be analysed by transmission electron microscopy (TEM) techniques. In this talk I will present our scanning TEM (STEM) investigations of unusual lattice reconstruction that occurs at the interfaces in twisted transition metal dicholcogenide bilayers [4]. Complementary scanning tunnelling measurements show that such reconstruction creates strong piezoelectric textures, which can be engineered by the application of applied field in the electron microscope [5]. This talk will also illustrate how we can use 2D heterostructures to produce a new design of in-situ liquid cell for the TEM [6,7]. This approach overcomes limitations of conventional silicon nitride window membranes allows atomic resolution imaging of adatom dynamics at solid-liquid interfaces [7]. We further show how a combination of STEM imaging and spectroscopy methods can be used to probe intercalation at the nanoscale and how these structures evolve as a function of time and annealing temperature (Figure 1) [8].

References

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Figures

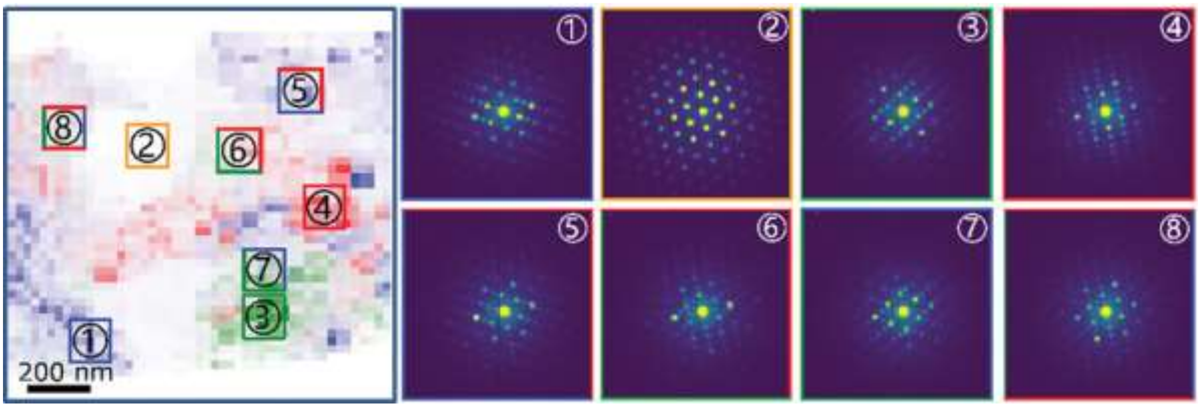

Figure 1: 4D STEM (scanning electron diffraction analysis of intercalation ordering in KMoS2 showing local disorder at the nanoscale (reproduced from [8].