Multi-structural analysis of epitaxially grown TMDs using 4D-STEM

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Epitaxial growth is a route to achieve high quality transition metal dichalcogenide (TMD) layers with appropriate structural and chemical designs. However, highly controlled layer production with expected electrical properties is still challenging due to the imperfection in growth process. For instance, slight misalignment and symmetrical crystal inversion in neighbouring nucleation sites result in a large amount of domain junctions at the stage of coalescence, causing a discrepancy in the properties between those measured in highly oriented epitaxial TMDs and the ones theoretically predicted from a perfect model system. In order to control growth process and to predict properties of grown materials up to wafer scale, multi-dimensional and multiscale structural analysis should be accessible in routine way. Four dimensional scanning transmission electron microscopy (4D-STEM) is a new acquisition technique allowing to simultaneously record 2D images in real and reciprocal spaces.[1] Multiple structural information at different scales can be reconstructed from signals appearing in diffraction pattern acquired at each pixel of the beam scan.

In this work, we demonstrate the use of 4D-STEM to study 2D materials epitaxially grown in both laboratory and industrial scales. Orientation, polarity and phase maps in various TMD monolayers are reconstructed at micron scale and directly correlated with both large scale XRD analysis and related atomic defect structures.[2]

References

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