Unveiling the Wafer Scale Perfection of 2D Materials Using Azimuthal Reflection High-Energy Electron Diffraction Map

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Project Summary: An efficient examination of the quality of as-grown wafer scale monolayer (ML) material remains quite a challenge. The structure of wafer-scale continuous epitaxial ML MoS_2 grown by metalorganic chemical vapor deposition (MOCVD) on sapphire at the 2DCC facility has been characterized using an *azimuthal* reflection high-energy electron diffraction (ARHEED) technique. With ARHEED, one can map not only 2D but also 3D reciprocal space structure of the ML statistically. From these maps, the symmetry, the in-plane and out-of-plane lattice constants, and the extended defects including the domain misorientation in the ML can be determined. Quantitative diffraction spot broadening analyses of the 3D reciprocal space map reveals low density defects and a small angular misalignment of orientation domains in ML MoS_2 and WS_2. This ARHEED methodology is applicable to other epitaxial ML materials on arbitrary crystalline or non-crystalline substrates. Published in *2D Materials 2021, 8, 025003.*

2DCC Role: The wafer-scale MoS_2 monolayer samples used for this study were grown by MOCVD in the 2DCC facility. The user project was initiated after 2DCC personnel (Redwing) visited RPI in 2017 to give a seminar and has resulted in two joint publications thus far. The user PI (G.C. Wang) and her graduate students have been active participants in 2DCC activities including participating in annual User Committee meetings, presenting posters at Graphene and Beyond and attending site visits.