Atomic defects in 2D materials studied by transmission electron microscopy

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Structural defects are considered as a parameter-tuning knob for tailoring physical properties of 2D materials. The ability to engineer atomic defects at nanometer scale opens up unique opportunities to alter and enhance electrical, optical, mechanical and magnetic properties. Despite the growing interest in 2D materials, growing defect-free 2D materials on desired substrates remains a challenge. Identification and characterization of these inevitable intrinsic growth defects are thus an essential process. Further exploitation of possible defect modification and manipulation might shed light on potential utilization of defect structures in device processing. Aberration Corrected Transmission Electron Microscopy (AC-TEM) is one of the most suitable techniques to study the atomic structure of 2D materials, enabling to visualize atomic defects and simultaneously to form new defects by electron irradiation [1]. In this work, we demonstrate a multi-scale analysis of WSe_2 monolayer grown by molecular beam epitaxy (MBE) in van der Waals regime [2], using a simultaneous real and reciprocal space imaging, so-called 4D-STEM. A possible correlation of atomic defects to large-scale structural analyses obtained by X-ray diffraction will be demonstrated for the purpose to study 2D epitaxial growth. In addition, we study the atomic defects diffusion under thermal electron irradiation inside TEM to explore the possibilities of defect engineering and materials design by combining their intrinsic and extrinsic defects.

REFERENCES

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