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Defect Heterogeneity in Monolayer WS2 Unveiled by Work Function Variance

Defects that are formed in two-dimensional (2D) materials during the chemical vapor deposition process are inevitable and critical for tailoring their optical and electrical properties. It is highly demanded to develop techniques to characterize the defects directly with enough resolution and throughput. Here, we report an effective methodology based on Kelvin probe force microscopy (KPFM) to unveil defect heterogeneity of 2D materials with a spatial resolution of ten nanometres and en-ergy sensitivity better than ten meV. KPFM mappings of WS2 monolayers exhibit interesting work function variances that are associated with defects distribution. This finding is verified by aberration-corrected scanning transmission electron mi-croscopy (STEM) and density functional theory (DFT) calculations. In particular, a strong correlation among the work func-tion, electrical and optical response to the defects is revealed. Our findings demonstrate the potential of KPFM as an effec-tive tool for exploring the intrinsic defects/quality of 2D materials.