QUANTITATIVE TRANSMISSION ELECTRON MICROSCOPY OF TWO-DIMENSIONAL TRANSITION METAL DICHALCOGENIDES

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Abstract

Layered transition metal dichalcogenides (TMDs) have been the subject of intense research for applications in nanoelectronics. Strong spin-orbit interactions combined with a direct band gap in monolayers of MX_2 (M: Mo, W; X: S, Se) have been shown to make TMDs very attractive for spintronics and valleytronics.

The layered structures of TMDs make them ideal for quantitative studies using transmission electron microscopy (TEM), which can further be compared with device performance. Here, we study WSe_2 samples with thickness of between 1 and 4 monolayers using several quantitative TEM techniques, including off-axis electron holography and high angle annular dark-field scanning TEM. We show that challenges associated with sample contamination, sample stability and electron-beam-induced charging can be minimised through experimental design and a carful choice of imaging parameters. We perform statistical analyses of phase shifts measured using medium-resolution and high-resolution off-axis holography to measure the mean inner potentials of the samples and the numbers of S or Se atoms in individual atomic columns, respectively.