

Supplementary Information

Spatially Separated Bipolar Transport and Surface Electron Accumulation in Tungsten Diselenide Nanostructures

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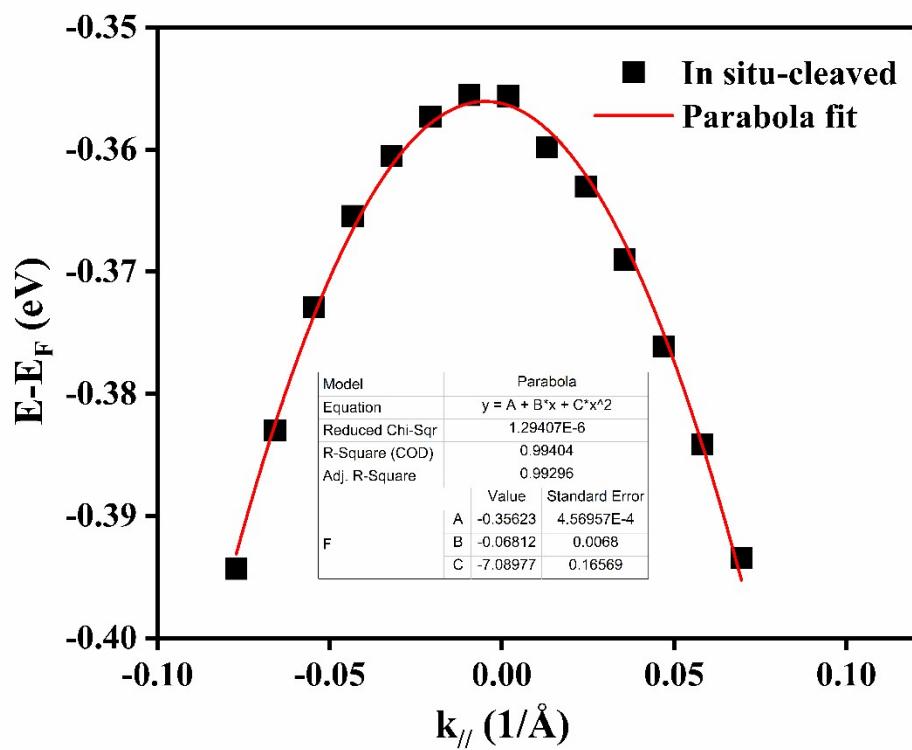


Fig. S1. The Parabolic fitting of VBM for the in situ-cleaved surface of WSe₂.

Note S1: The effective mass evolution across pure, Se-vacant, and O-substituted WSe₂ directly reflects the underlying changes in band dispersion induced by defect chemistry. Pristine WSe₂ exhibits moderately light carriers ($m_e^* = 0.403 m_0$, $m_h^* = 0.548 m_0$), consistent with the well-dispersed bands arising from strong W–Se hybridization at the K valley. Introducing a Se vacancy disrupts this bonding environment and generates localized defect states that flatten both the conduction- and valence-band edges, leading to substantially heavier effective masses ($m_e^* = 0.603 m_0$, $m_h^* = 0.842 m_0$). This pronounced reduction in curvature reflects carrier localization and suppressed mobility commonly associated with vacancy defects. In contrast, substituting oxygen at the Se site removes the vacancy-induced localization by forming stronger and more stable W–O bonds, which restore the delocalized character of the band edges and enhance their curvature. As a result, the electronic structure recovers toward that of the pristine material, yielding even lighter carrier masses ($m_e^* = 0.393 m_0$, $m_h^* = 0.410 m_0$), particularly for holes. These trends demonstrate that Se vacancies degrade transport by weakening orbital overlap, whereas O substitution effectively passivates the defect, reestablishes bonding coherence, and improves carrier dispersibility.

Table S1: Calculated effective mass of electron (m_e^*) and holes (m_h^*) of WSe₂ with different conditions

System	m_e^*	m_h^*
Pure WSe ₂	0.403m0	0.548m0
Se vacant WSe ₂	0.603m0	0.842m0
O substituted WSe ₂	0.393m0	0.410m0