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Stitch up the Grain Boundaries in WS2 Monolayers with Conjugated Molecules

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Abstract
Transition metal dichalcogenides (TMDCs) are pioneering an era of low-dimensional electronics. Recent progress in large-area synthesis of monolayer tungsten disulfide (WS_2) is paving the way for various potential optoelectronic applications, because of its inherent high photoluminescence (PL) yield and high electron mobility.[1] However, the arbitrary distribution of point defects and grain boundaries (GBs) diminishes its spatial homogeneity, obstructing the further development of system-on-chip (SoC). Large efforts have been made to suppress the inhomogeneity from synthesis to post-treatment[2], yet little is made about cross-GB electron transport.[3] Herein, we utilize a conjugated small molecule (benzene-1,4-dithiol, BDT) to heal the point defects and stitch up the line defects in chemical vapor deposition (CVD) method grown WS_2. Remarkably, the treated CVD-grown WS_2 exhibits drastically improved uniformity in terms of PL brightness and electron mobility (200 times enhancement for devices across GBs), comparable or superior to scotch-tap exfoliated single crystals. Furthermore, using temperature dependent PL spectroscopy and transmission electron microscopy (TEM), we identify the defective nature of GBs and manifest the interaction between the GBs and the conjugated molecule BDT.

References

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Figures

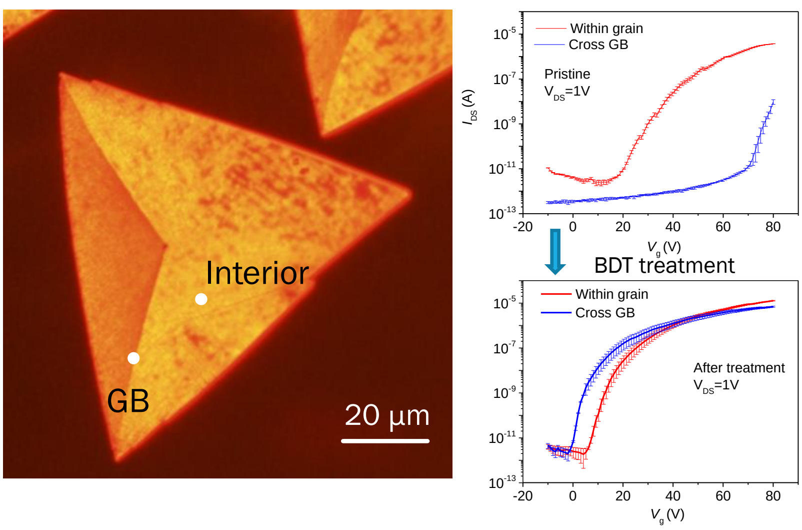

Figure: Photoluminescence spectrum mapping of a CVD grown WS2 monolayer. And the transfer curves of the transistor devices before and after BDT treatment.