Benchmarking monolayer MoS_2 and WS_2 field-effect transistors

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Project Summary: To assess the potential of transition metal dichalcogenides (TMDs) for future circuits, it is important to study the variation in key device parameters across a large number of devices. Here we benchmark device-to-device variation in field-effect transistors (FETs) based on wafer-scale monolayer MoS_2 and WS_2. Our study involves 230 MoS_2 FETs and 160 WS_2 FETs with channel lengths ranging from 5 µm down to 100 nm. We use statistical measures to evaluate key FET performance indicators for benchmarking these TMD monolayers against existing literature as well as ultra-thin body Si FETs. Our results show consistent performance of the 2D FETs across 1×1 cm^2 chips owing to high quality uniform layers and clean transfer onto device substrates. We demonstrate record high carrier mobility of 33 $cm^2V^{-1}s^{-1}$ in WS_2 FETs, which is a 1.5X improvement compared to the best literature report. Our results confirm the technological viability of 2D FETs in future integrated circuits. Published in *Nature Communications 2021, 12, 1-12.*

2DCC Role: The wafer-scale MoS_2 and WS_2 monolayer samples used for this study were grown by metalorganic chemical vapor deposition (MOCVD) in the 2DCC facility. The device results provide a benchmark for academic and industry users who are working with similar 2DCC material.