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Wafer-Scale Monolayer Films of Semiconducting Metal Dichalcogenides for High-Performance Electronics SAIEN XIE, KIBUM KANG, LUJIE HUANG, YIMO HAN, PINSHANE HUANG, KIN FAI MAK, CHEOL-JOO KIM, DAVID MULLER, JIWOONG PARK, Cornell University — Two-dimensional semiconducting transition metal dichalcogenides (TMDs) have shown their potential in electronics, optoelectronic and valleytronis. However, large-scale growth methods reported to date have only produced materials with limited structural and electrical uniformity, hindering further technological applications. Here we present a 4-inch scale growth of continuous monolayer molybdenum disulfide (MoS2) and tungsten disulfide (WS2) films that show excellent structural and electrical uniformity over the entire wafer using metal-organic chemical vapor deposition. The resulting monolayer films show high mobility of 30 cm2/Vs at room temperature, as well as the phonon-limited transport for MoS2, regardless of the channel length and device location. They allow for the batch fabrication of monolayer MoS2 field effect transistors with a 99% yield, which display spatially-uniform n-type transistor operation with a high on/off ratio. We further demonstrate the multi-level growth and fabrication of vertically-stacked monolayer MoS2 films and devices, which could enable the development of novel three-dimensional circuitry and device integration.

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