High-Mobility Multilayered MoS_2 Flakes with Low Contact Resistance Grown by Chemical Vapor Deposition

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Multilayered (ML) MoS_2 shows higher mobility than their single layered counterparts, but the controllable synthesis and contact engineering remain the key challenges to harvest their greatest potential. To realize the controllable growth of high quality ML MoS_2 and achieve the ultimate performanceof 2D MoS_2, we developed a CVD approach for growing highly crystalline ML MoS_2 flakes with gradually shrinking basal planes from the bottom to the top layers. This unique geometry enables the direct contacts of each MoS_2 layer to the electrodes and therefore, the CVD-grown ML MoS_2 exhibits much higher mobility and current density than mechanically exfoliated ML MoS_2 and thus makes 2D MoS_2 more competitive for future electronics. Moreover, the atomic edge structures, stacking configuration and structure-properties dependence were also systemically investigated with various microscopic and spectroscopic characterizations and revealed that the MoS_2 layers were stacked in a well-defined AA order and terminated with atomically smooth Mo zigzag (zz)-edges. Besides their promising applications in high performance field-effect transistors (FETs) and rectifying diodes, these AA-stacked MoS2 flakes showing broken inversion nature also hold great potential for fundamental studies on optical nonlinearity and valley physics.

References

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Figures

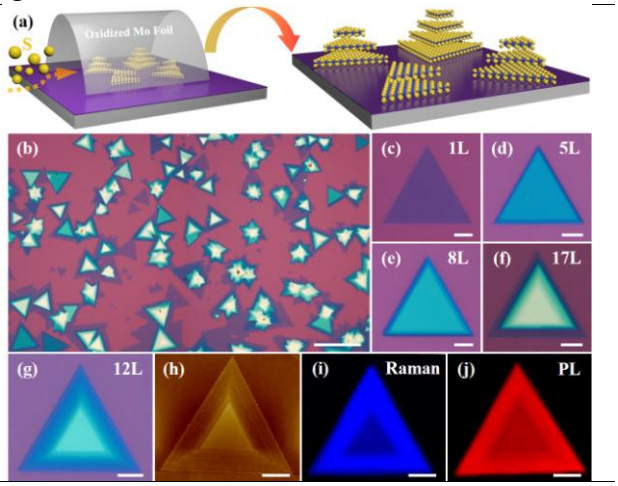

Figure 1: Synthesis of MoS_2 flakes with varied layer numbers by the rapid sulfurization of **electrochemically oxidized Mo foils** in gas phase in a confined space

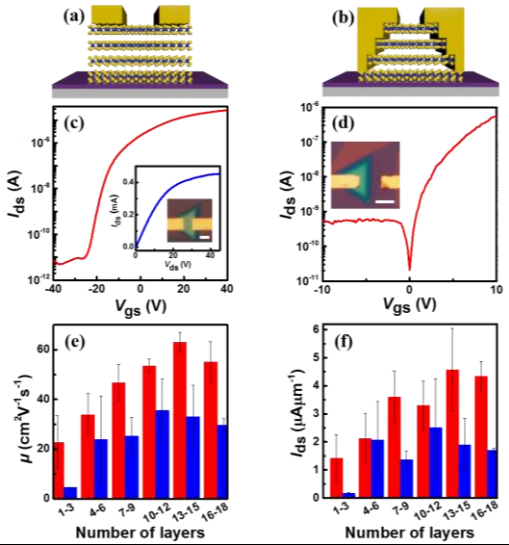

Figure 2: Electrical performances of the CVD-grown ML MoS_2 flakes. a, b) Schematic illustrations of the electrical contact geometries in ML exfoliated MoS_2 and CVD-grown MoS_2 flakes. c) I_{ds}–V_{gs} and I_{ds}–V_{ds} characteristics of a 16L MoS_2 flake. d) I_{ds}–V_{ds} characteristics of 1L–8L MoS_2 junction measured at a gate voltage of 0 V. e, f) Statistics of electron mobility (e) and current measured at V_{gs} = 40 V and V_{ds} = 1 V (f) as the function of layer numbers in CVD-grown MoS_2 flakes (red columns) and mechanically exfoliated MoS_2 flakes (blue columns).