(Supplemental Document) ALD-Induced Doping Effect in 2D MoS_2 FETs: Roles of Oxidant Chemistry and MoS_2 Quality

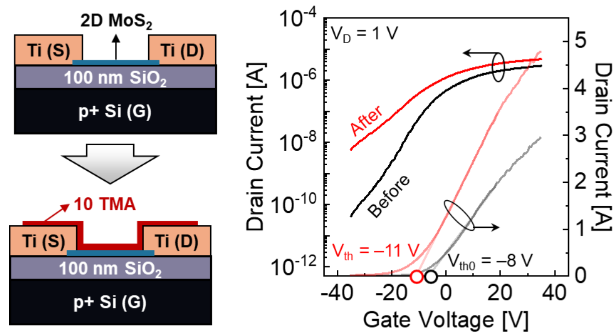

Fig. 1. *In-situ* half-cycle TMA exposure on 2D MoS_2-FET (ALDo signature). Schematic of a back-gated test structure, used to probe half-cycle effects during ALD process. After TMA exposure, the transfer response shows the negative shift of transfer curves, indicating the ALD-induced doping effect.

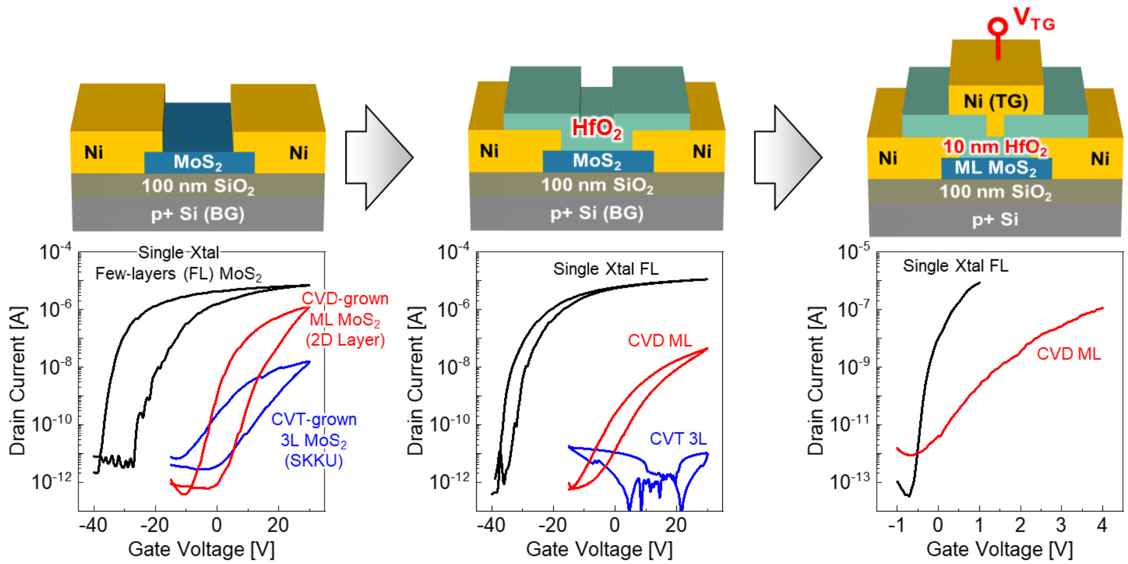

Fig. 2. *Ex-situ* 10-nm gate-dielectric integration with MoS_2 quality dependency. Process schematic for MoS_2 FET integration. Representative transfer characteristics compare different MoS_2 sources/qualities, showing minimal net change for high-quality single-crystal MoS_2 but noticeable degradation for CVD- and CVT-grown MoS_2 after few-nanometer HfO_2 formation.

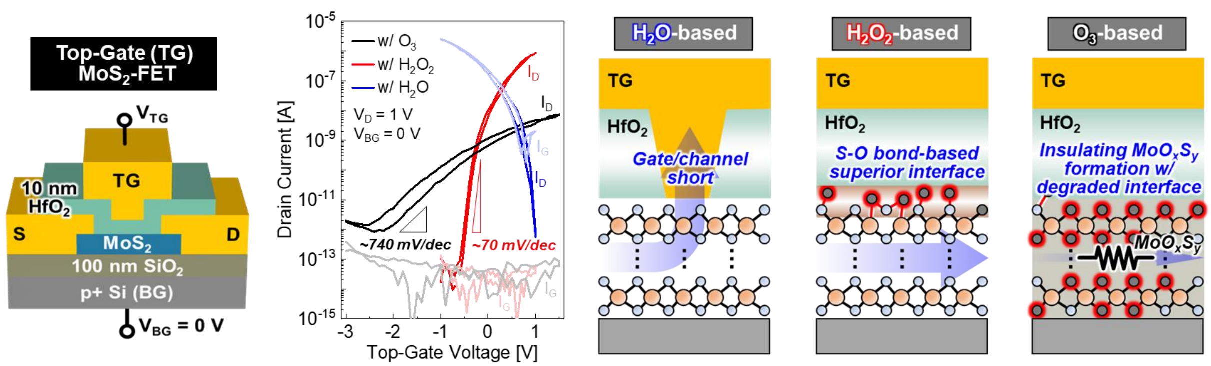

Fig. 3. Oxidant chemistry effects for HfO_2/MoS_2 interface and top-gated device behavior. Top-gated MoS_2-FET structure and representative electrical characteristics illustrating oxidant-dependent ALD outcomes. H_2O-based ALD can lead to gate/channel shorting, whereas O_3-based ALD tends to induce stronger surface perturbation, resulting in worsened electrical behavior. In contrast, H_2O_2-based ALD promotes an S-O-bond-stabilized interface with improved switching and reduced leakage.