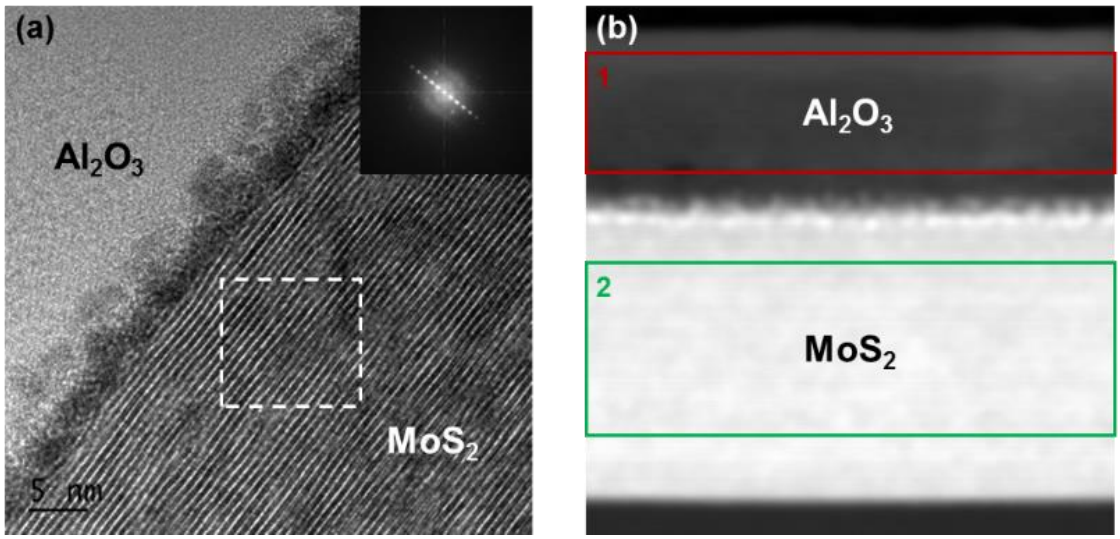
applied sciences

MDPI

Supplementary Material :Temperature-Dependent Electrical Properties of Al_2O_3 Passivated Multilayer MoS_2 Thin-Film Transistors

Keywords: transition metal dichalcogenide; molybdenum disulfide; thin-film transistor; passivation; contact resistance; intrinsic mobility



(c)

Atomic %	O-K	Al-K	S-KA	Mo-KA	Si-KA
1	57.83	41.18	0.26	0.12	0.61
2	5.42	1.56	60.28	29.95	2.79

Figure S1. (**a**) Cross-sectional TEM image of a MoS_2 encapsulated by Al_2O_3. Inset: FFT patterns of the MoS_2 obtained in the area marked with the white dashed line. (**b**) HAADF image of a MoS_2 TFT with Al_2O_3 passivation; (**c**) atomic percentage of the atoms contained in the area marked with red and green rectangles in (**b**).

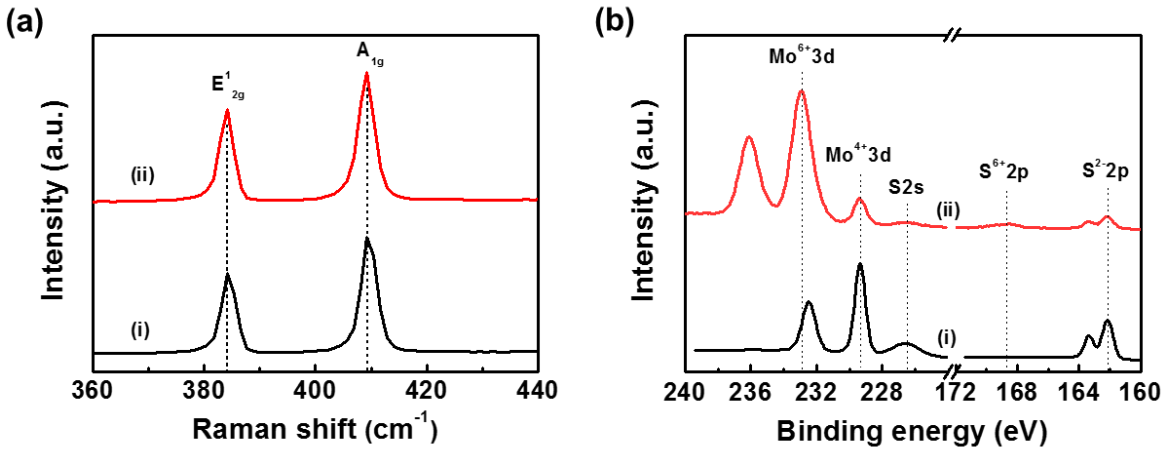


Figure S2. (**a**) Raman and (**b**) XPS spectra of (i) pristine and (ii) UV-ozone treated MoS_2.

Variations of the physical properties in multilayer MoS_2 with respect to the UV-ozone treatment were investigated using Raman and X-ray photoelectron spectroscopy (XPS). In Figure S2a, both ~~of the two~~ spectra show two representative peaks belonging to MoS_2, which are assigned to the E^1_{2g} peak at 384 cm^{-1} and the A_{1g} peak at 409 cm^{-1}, respectively [S1–3]. The Raman spectra exhibit no apparent variation in the peak intensity and position, indicating that negligible defects or lattice disorders are induced by the UV-ozone treatment.

As shown in the XPS spectra (Figure S2b), two peaks with relatively high intensities are observed at 229.3 eV and 232.4 eV for the pristine MoS_2 (i.e., before UV-ozone treatment), which correspond to Mo^{4+} 3d. ~~Another~~ Other weak peaks corresponding to S^{2-} 2p are identified at 162.1 eV and 163.3 eV [S4,5]. However, after UV-ozone treatment, the intensities of the XPS peaks originat~~inged~~ from Mo^{4+} 3d and S^{2-} 2p were clearly reduced. In addition, ~~a~~ strong doublet peaks are observed at the higher binding energies of 232.7 and 235.8 eV, implying formation of Mo–O bonding (Mo^{6+} 3d) [S6]. New peaks also appear at 168.5 and 169.7 eV, corresponding to S^{6+} 2p (S–O bonding) [S3]. These results indicate that the MoS_2 surface becomes oxidized during UV-ozone treatment.

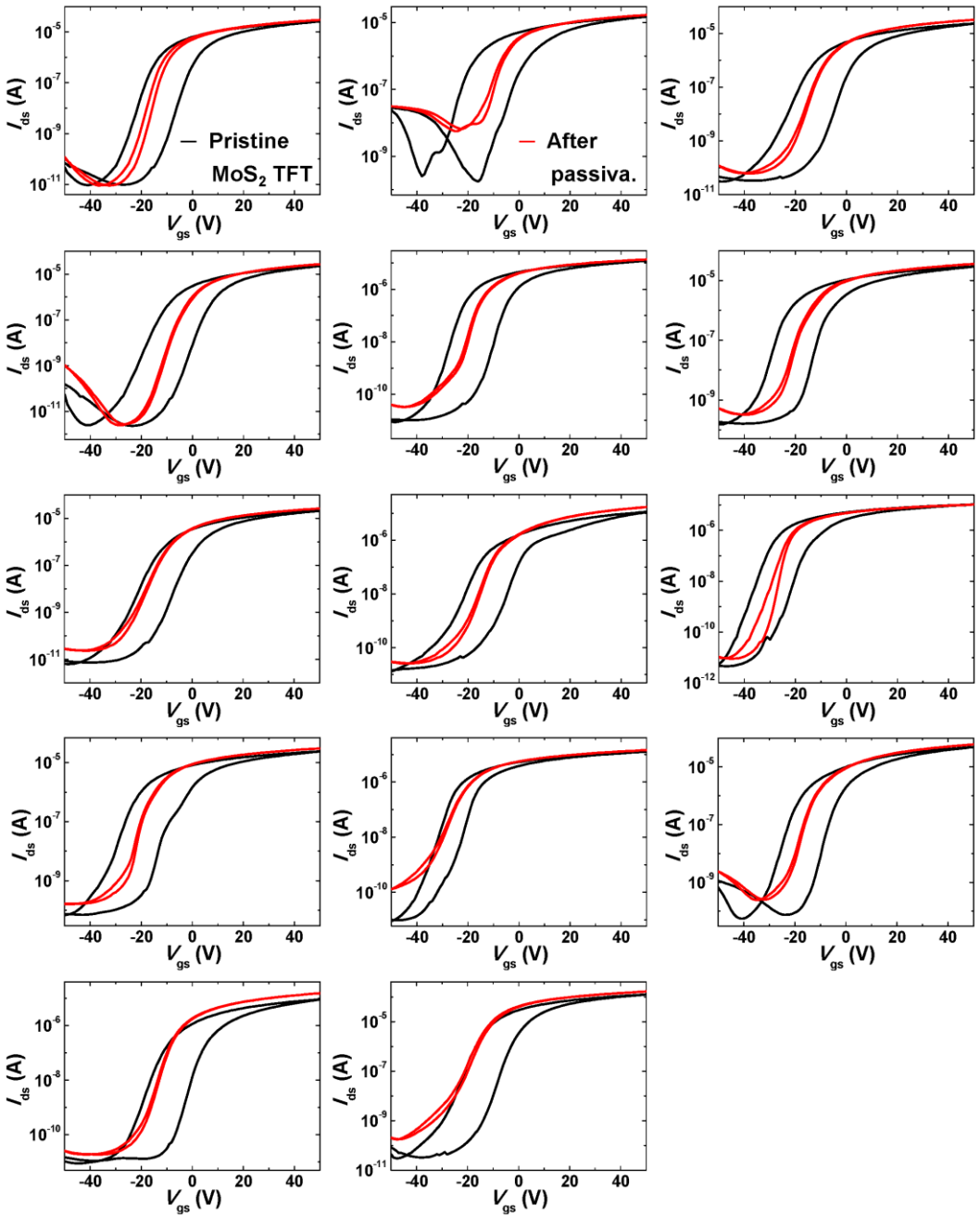


Figure S3. Transfer characteristics of 14 MoS_2 TFTs before (black line) and after (red line) Al_2O_3 passivation.

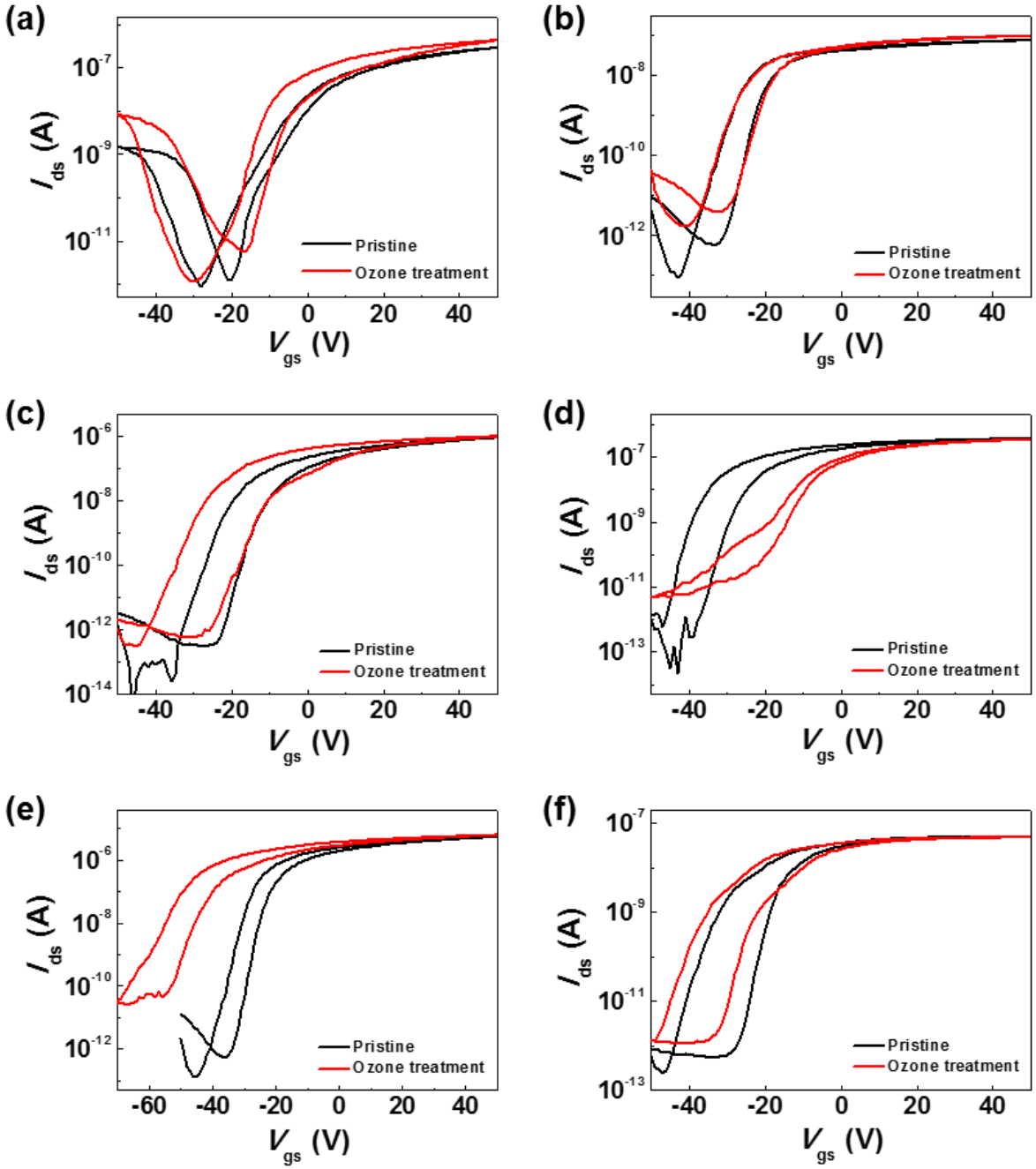


Figure S4. Transfer characteristics of six MoS_2 TFTs without Al_2O_3 passivation before (i.e., pristine) and after UV-ozone treatment.