Electronic Supplementary Information

Electromechanical failure of MoS_2 nanosheets

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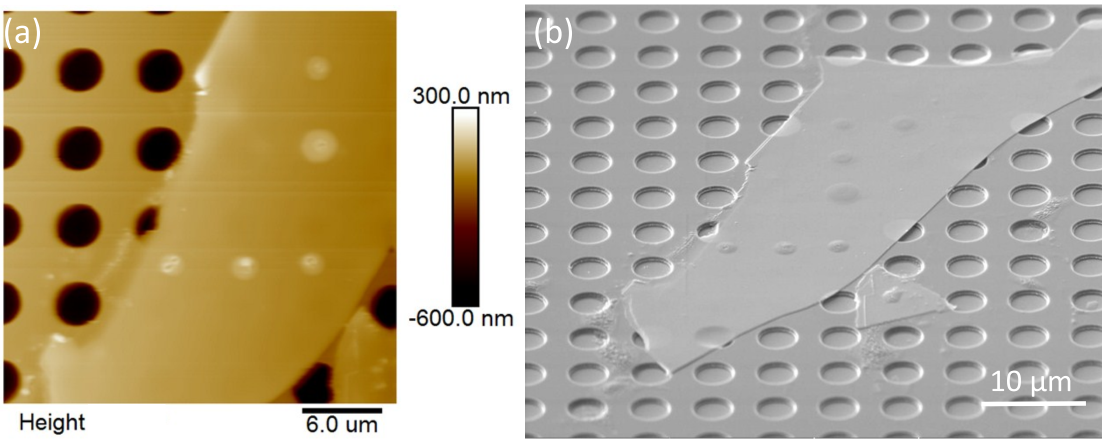

Fig. S1 (a) AFM height image of a MoS_2 nanosheet. Obvious electromechanical failure zones can be observed on the suspended and supported parts of MoS_2nanosheet. (b) SEM image of the corresponding MoS_2 nanosheet.

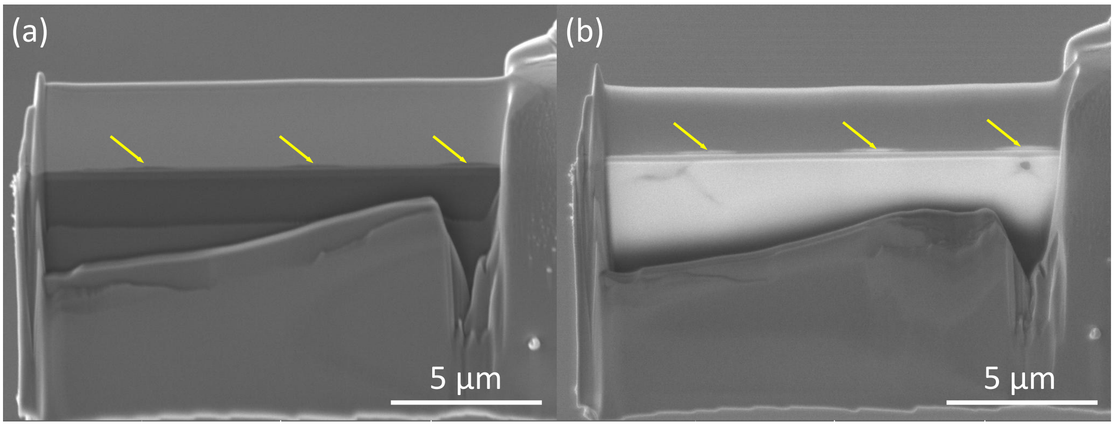

Fig. S2 (a,b) SEM images during the FIB etching process. The yellow inset arrows reflect the swelling MoS_2 nanosheet in the electromechanical failure zones.

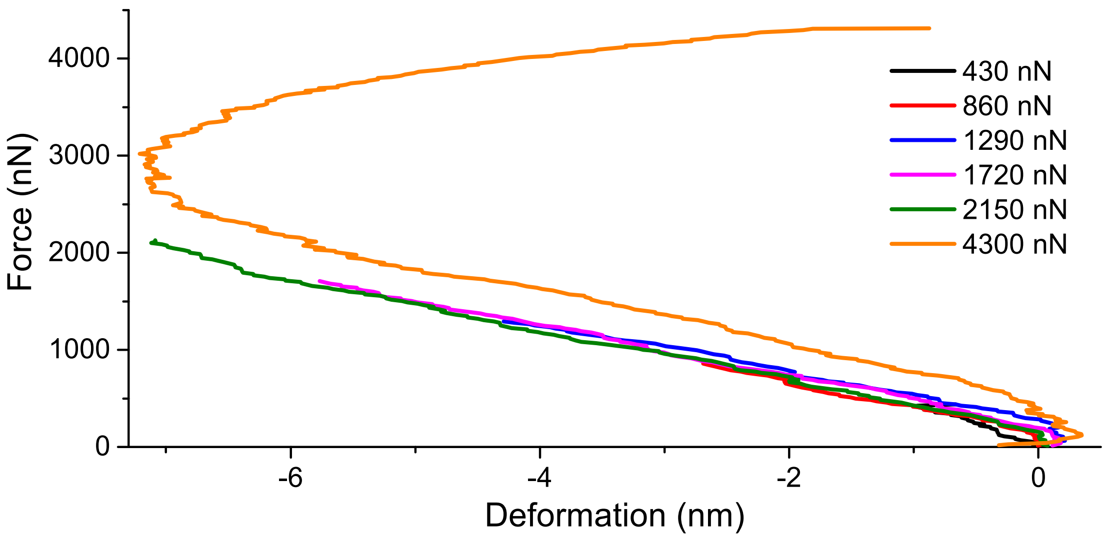

Fig. S3 Force-deformation curves of supported MoS_2 nanosheet under the fixed bias of +6 V with increasing applied load. The negative variation trend of the force-deformation curve is attributed to the deformation of AFM probe. The positive of force deformation curve at the applied load of 4300 nN is caused by the puncture of the swelling MoS_2 nanosheet.

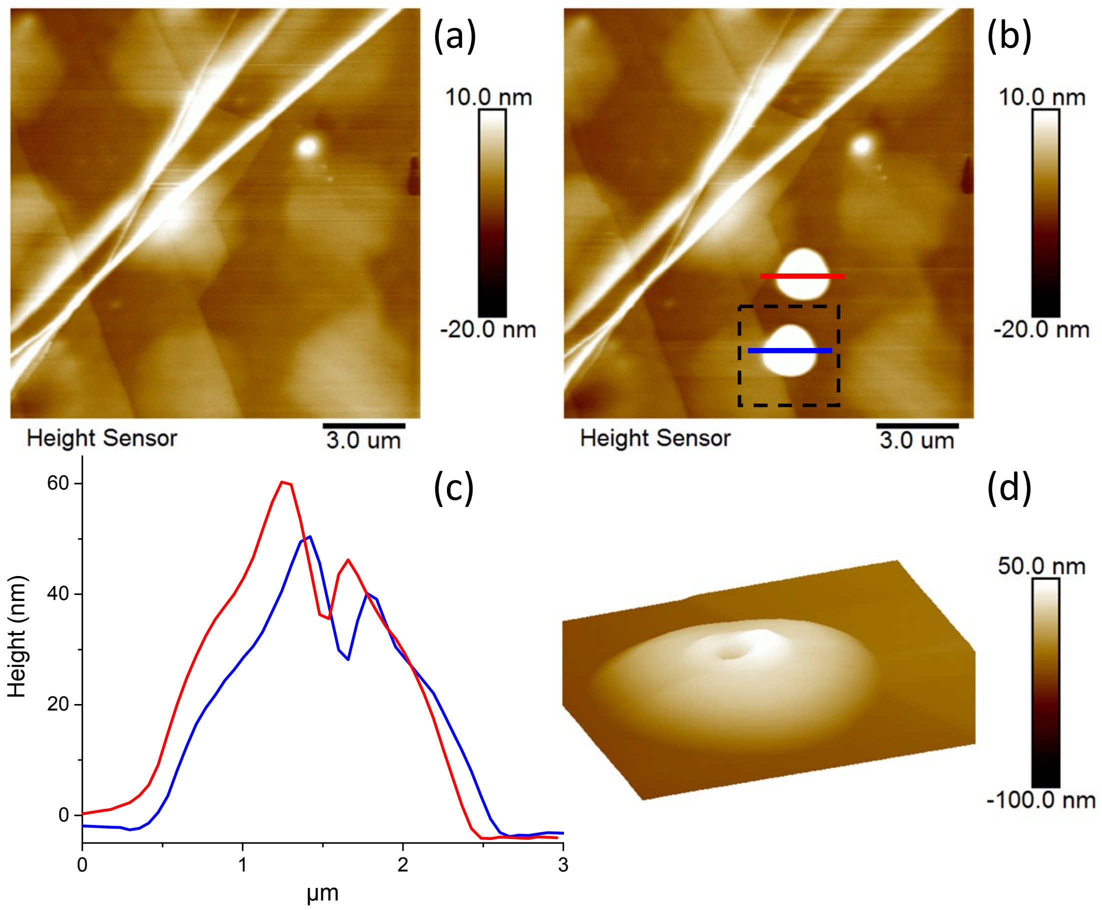

Fig. S4 Electromechanical failures of MoS_2 nanosheets supported on the $Cr/SiO_2/Si$ substrate. Obvious swelling of the failure zones can be observed. (a) Height image of MoS_2 nanosheet before the conductive AFM nanoindentations. (b) Height image of MoS_2 nanosheet after the conductive AFM nanoindentations. (c) Height profiles of the section lines in (b). (d) 3D height image of the corresponding faliure zone in (b).

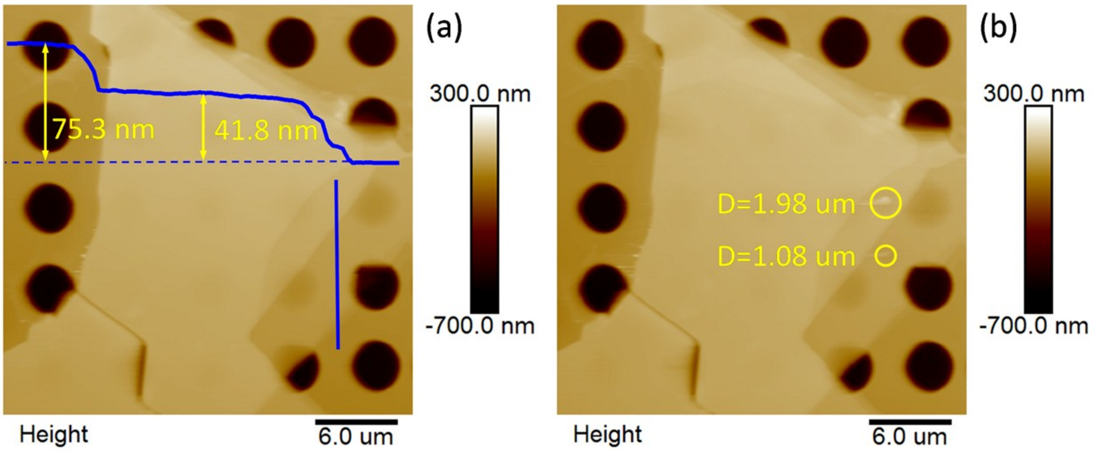

Fig. S5 Effect of thickness on the electromechanical failure extent of supported MoS_2 nanosheet. (a) Height image before the conductive AFM nanoindentation. (b) Height image after the conductive AFM nanoindentation. The experimental parameters were kept the same during the conductive AFM nanoindentation process. Interestingly, the shapes of the failure zones look like an ideal circle and the diameter increases with the thickness. This is attributed to the circumferentially homogeneous heating oxidation failure of the MoS_2 nanosheet and the thicker ones suffer more failure layers. Besides, more gas bubbles can be formed in the thicker nanosheets.

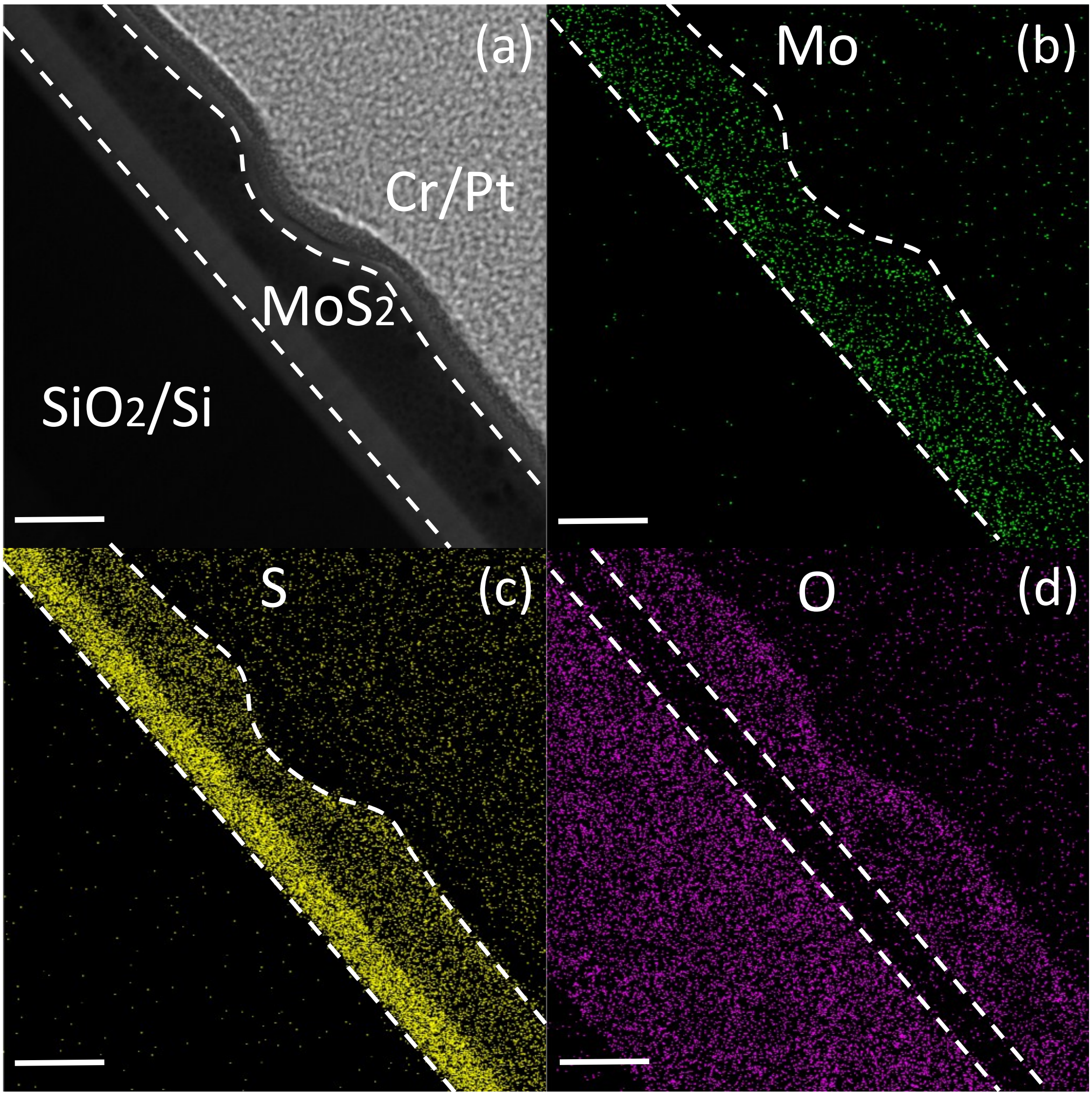

Fig. S6 TEM images of MoS_2 nanosheet. Scale bar: 100 nm. (a) Electron image of MoS_2 in the failure area. The white dashed lines distinguish the different materials. (b) TEM mapping of Mo element. The area between the white dashed lines reflect the existence of Mo and shows analmost uniform distribution. (c) TEM mapping of S element. The area between the white dashed lines reflect the existence of S, and an obvious boundary can be observed between the crystalline and failure MoS_2. (d) TEM mapping of O element. The area between the white dashed lines reflects the absence of O element and it accords well with the area of the crystalline MoS_2. This can prove the oxidation of the failure MoS_2 in the upper layers.