Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Vertical $Al_2Se_3/MoSe_2$ Heterojunction on Sapphire Synthesized by Using Ion Beam

Hsu-Sheng Tsai[1*], Jhe-Wei Liou[2], Yi-Chung Wang[3], Chia-Wei Chen[3], Yu-Lun Chueh[3], Ching-Hung Hsiao[3], Hao Ouyang[3], Wei-Yen Woon[2*], Jenq-Horng Liang[1,4*]

[1] *Institute of Nuclear Engineering and Science, National Tsing Hua University, Hsinchu 30013, Taiwan, R.O.C.*

[2] *Department of Physics, National Central University, Jungli 32054, Taiwan, R.O.C.*

[3] *Department of Material Science and Engineering, National Tsing Hua University, Hsinchu 30013, Taiwan, R.O.C.*

[4] *Department of Engineering and System Science, National Tsing Hua University, Hsinchu 30013, Taiwan, R.O.C.*

**Correspondence to: b91520016@yahoo.com.tw, wywoon@phy.ncu.edu.tw and jhliang@ess.nthu.edu.tw*

Calculations

In Fig. S2a, the length of the dashed line, which contains a quadruple reciprocal vector, is equal to 8.933 nm^{-1}, so that the length of the reciprocal vector is 2.233 nm^{-1}. The inverse of 2.233 nm^{-1} is equal to 0.4478 nm that corresponds to the (011) interplanar distance (0.4587 nm) of Al_2Se_3. On the other hand, the length (16.591 nm^{-1}) of the dashed line as shown in Fig. S2b contains a quadruple reciprocal vector. Hence, the length of the reciprocal vector is 4.148 nm^{-1}. The inverse of 4.148 nm^{-1} is equal to 0.241 nm that corresponds to the (400) interplanar distance (0.25 nm) of Al_2Se_3. These calculations, which derived from the experimental results, are in agreement with the theory and the error rate is less than 5%, indicating that the results are believable.

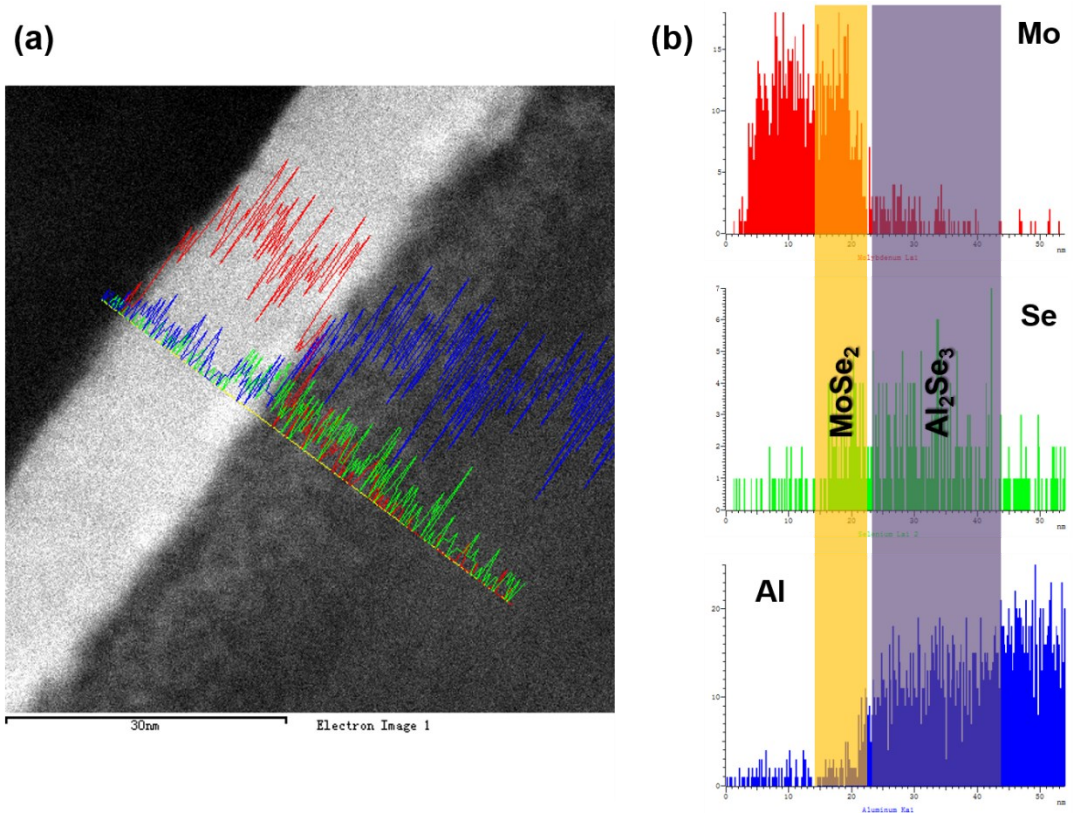

Fig. S1 (a) STEM dark-field image of the $MoSe_2/Al_2Se_3$/sapphire layer structure. (b) Depth concentration distribution of Mo, Se, and Al.

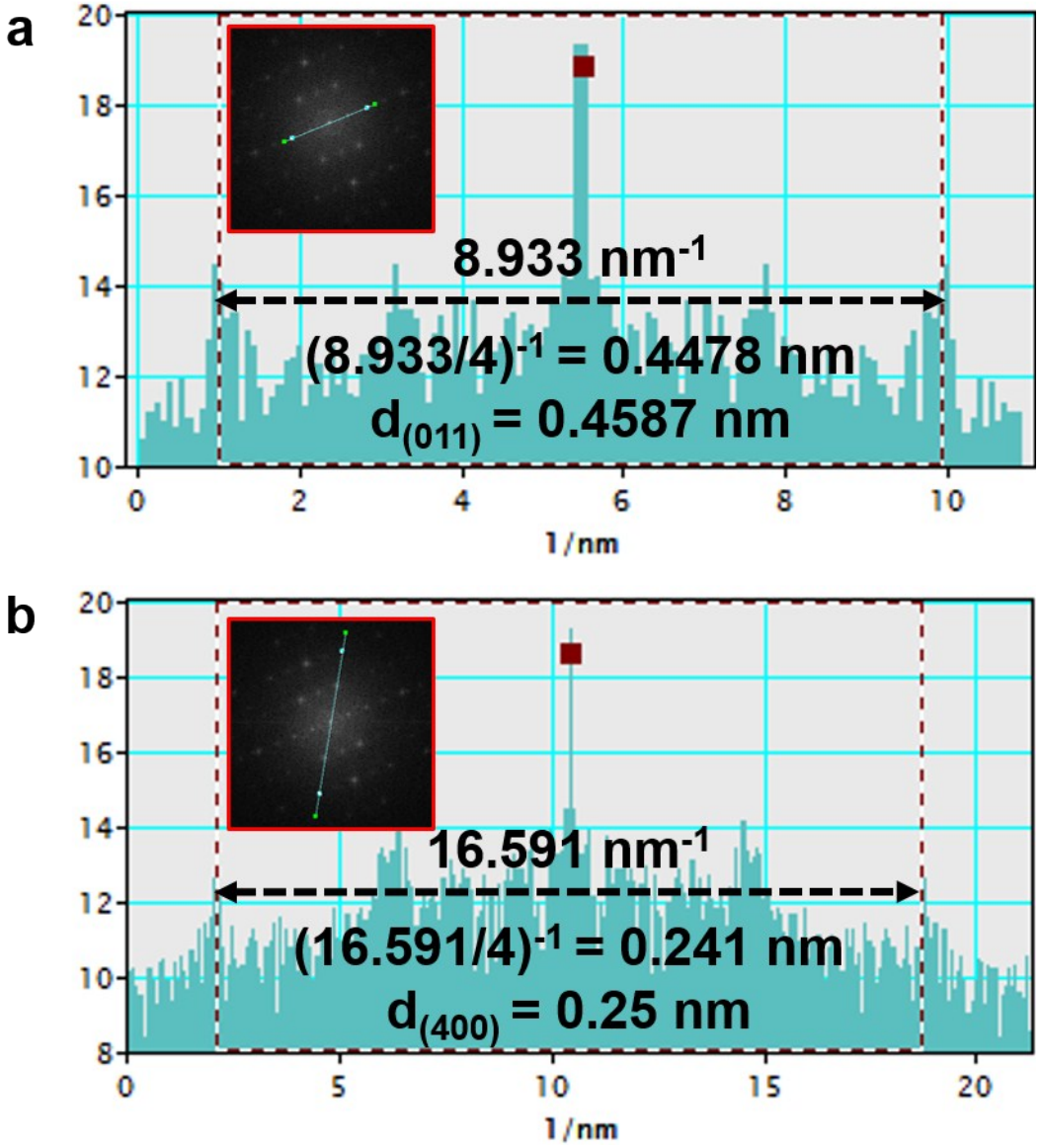

Fig. S2 (a) The distance between (011) reciprocal points of Al_2Se_3. (b) The distance between (400) reciprocal points of Al_2Se_3.

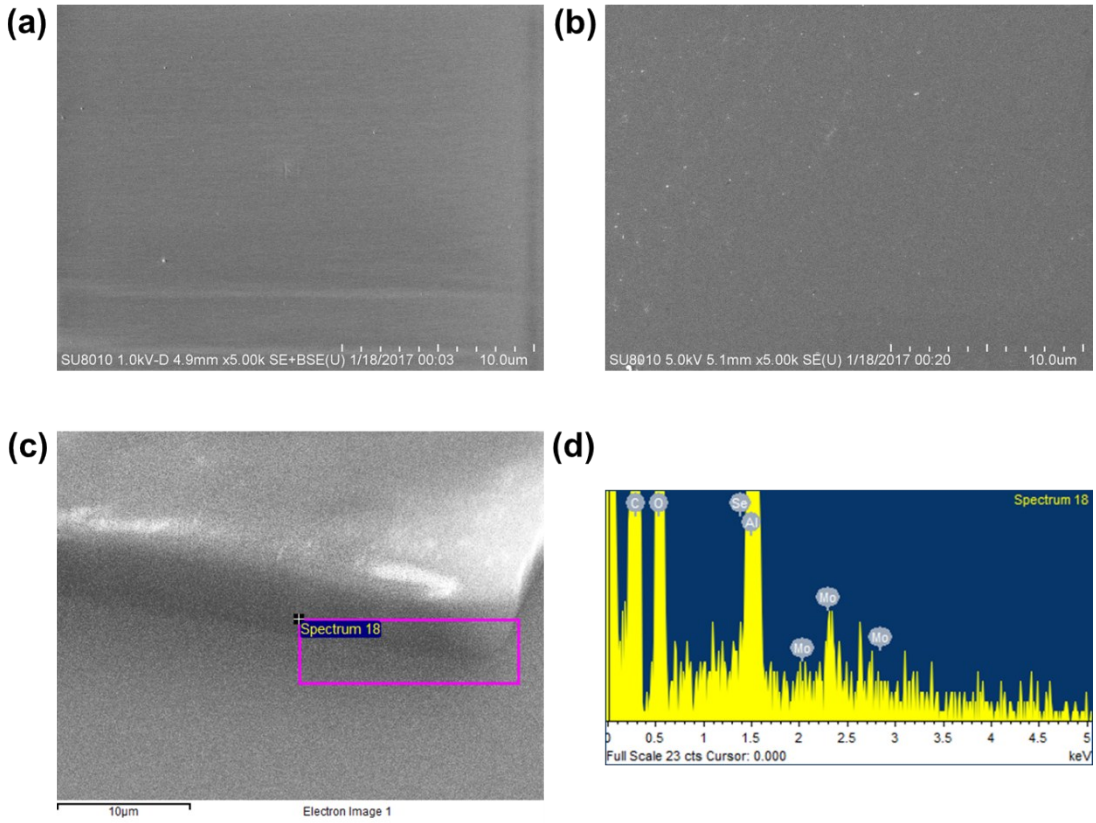

Fig. S3 (a) The top-view SEM image of pristine sapphire. (b) The top-view SEM image of Mo film on sapphire. (c) The tilt-view SEM image of the patterned $MoSe_2/Al_2Se_3$ on sapphire. (d) The EDS spectrum of the area corresponding to the rectangle in (c).