Supplementary materials

Epitaxial configuration of unidirectionally-aligned MoS_2 monolayer on sapphire

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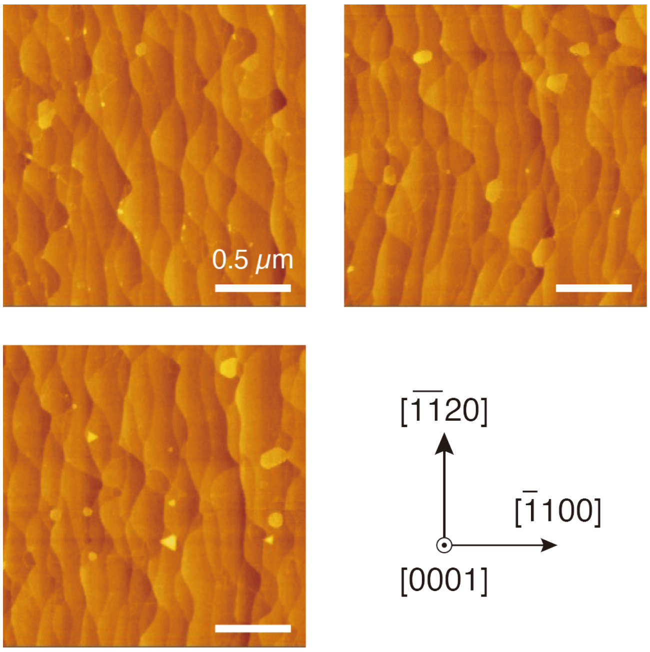

Figure S1. Representative AFM images measured from randomly selected areas of the ML-MoS_2 sample grown on the sapphire (0001) substrate at 975˚C for 60 min. The image dimensions are 2 x 2 μm^2. It is clearly seen that the MoS_2 ML is continuous and that the nucleation of second-layer MoS_2 islands is very limited.

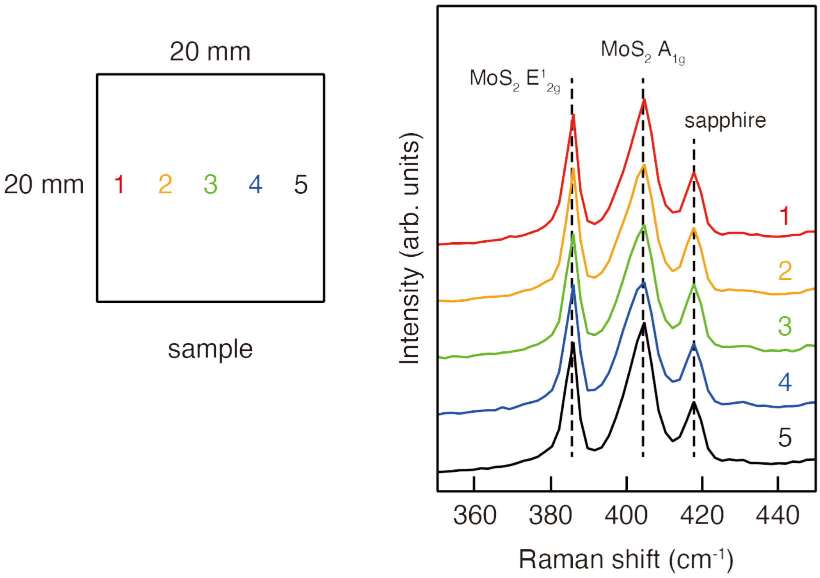

Figure S2. Raman spectra taken from five locations across the ML-MoS$_2$ sample grown on the sapphire (0001) substrate at 975°C for 60 min. The difference in peak positions for the E$^1_{2g}$ and A$_{1g}$ modes are less than 19 cm^{-1}, which provides evidence for the 1 ML-thick MoS$_2$ film [1].

[1] C. Lee, H. Yan, L.E. Brus, T.F. Heinz, J. Hone, and S. Ryu, Anomalous Lattice Vibrations of Single- and Few-Layer MoS$_2$, ACS Nano, 4, 2695-2700 (2010).

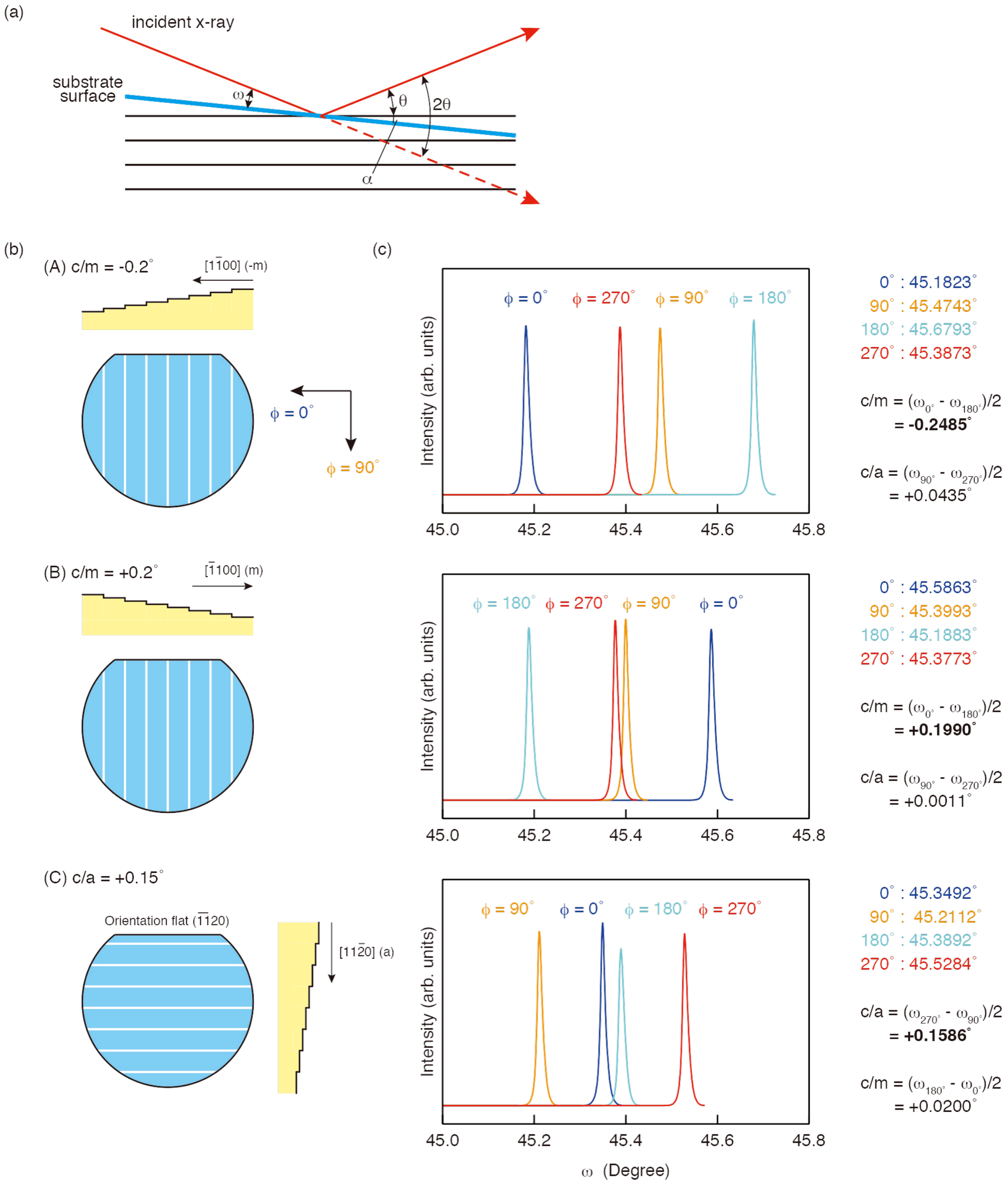

Figure S3. (a) Schematic drawing of the setup for XRD rocking curve measurements. (b) Schematic illustrations of sapphire substrate with miscut angles of ~0.2° along the [1-100] (A), [-1100] (B) and [11-20] (C) directions. (c) Measured XRD rocking curves. The actual miscut angles are c/m =-0.2485° (a), c/m =+0.199° (b), and c/a =+0.1586° (c). The incidental miscut angles for the orthogonal directions are negligible; 0.0435° (a), 0.0011° (b), and 0.0200° (c).

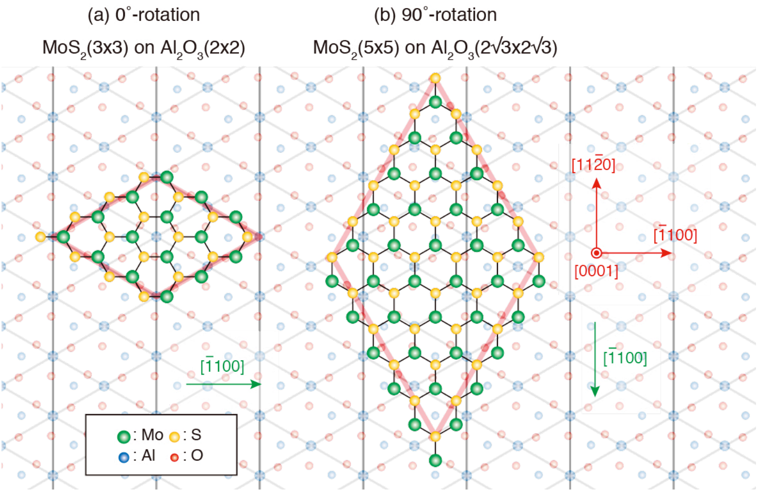

Figure S4. Schematic illustrations of 0° and 90° domains of ML-MoS2 on the sapphire substrate. In the 0° domain, the MoS_2(3x3) supercell is lattice-matched with the Al_2O_3(2x2) cell (lattice mismatch =-0.42 %). In the 90° domain, MoS_2(5x5) cell is nearly lattice-matched to Al_2O_3(2√3x2√3)-R30° cell (lattice mismatch = -4.18 %).