

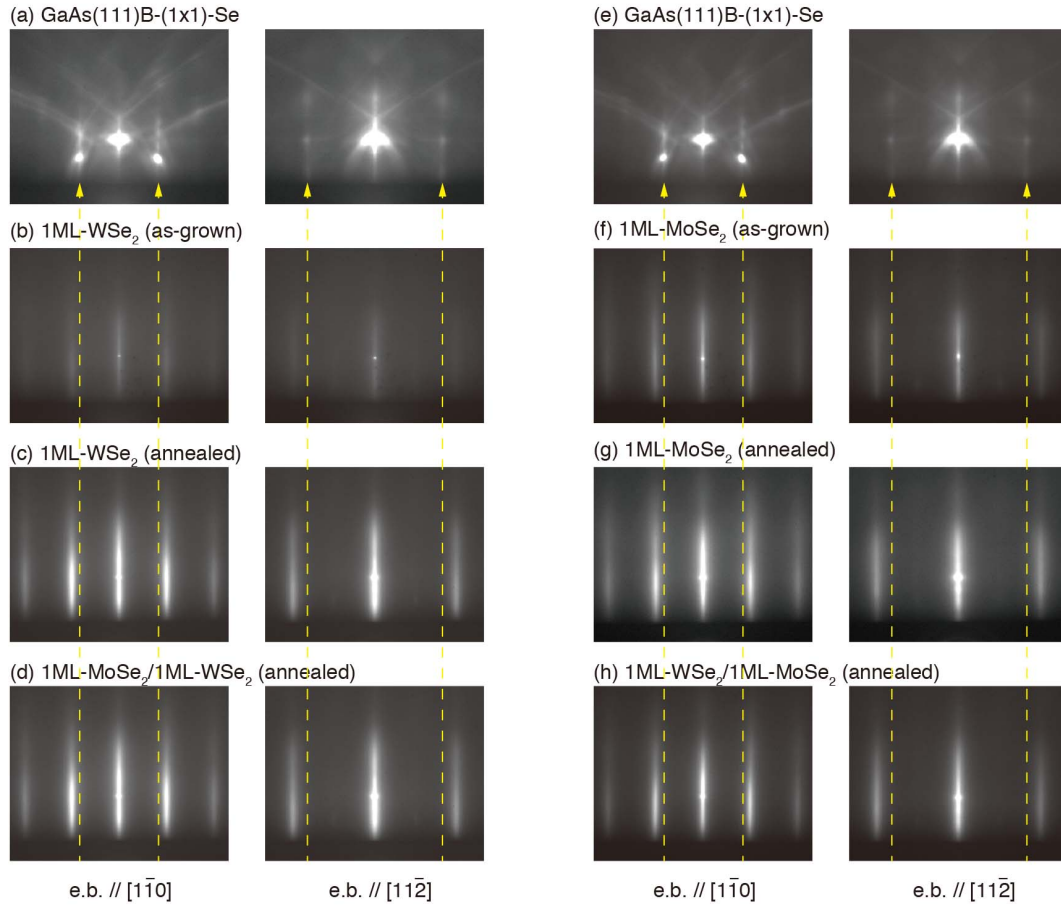
# Supporting Information

## Two-Dimensional WSe<sub>2</sub>/MoSe<sub>2</sub> Heterostructures Grown by Molecular-Beam Epitaxy

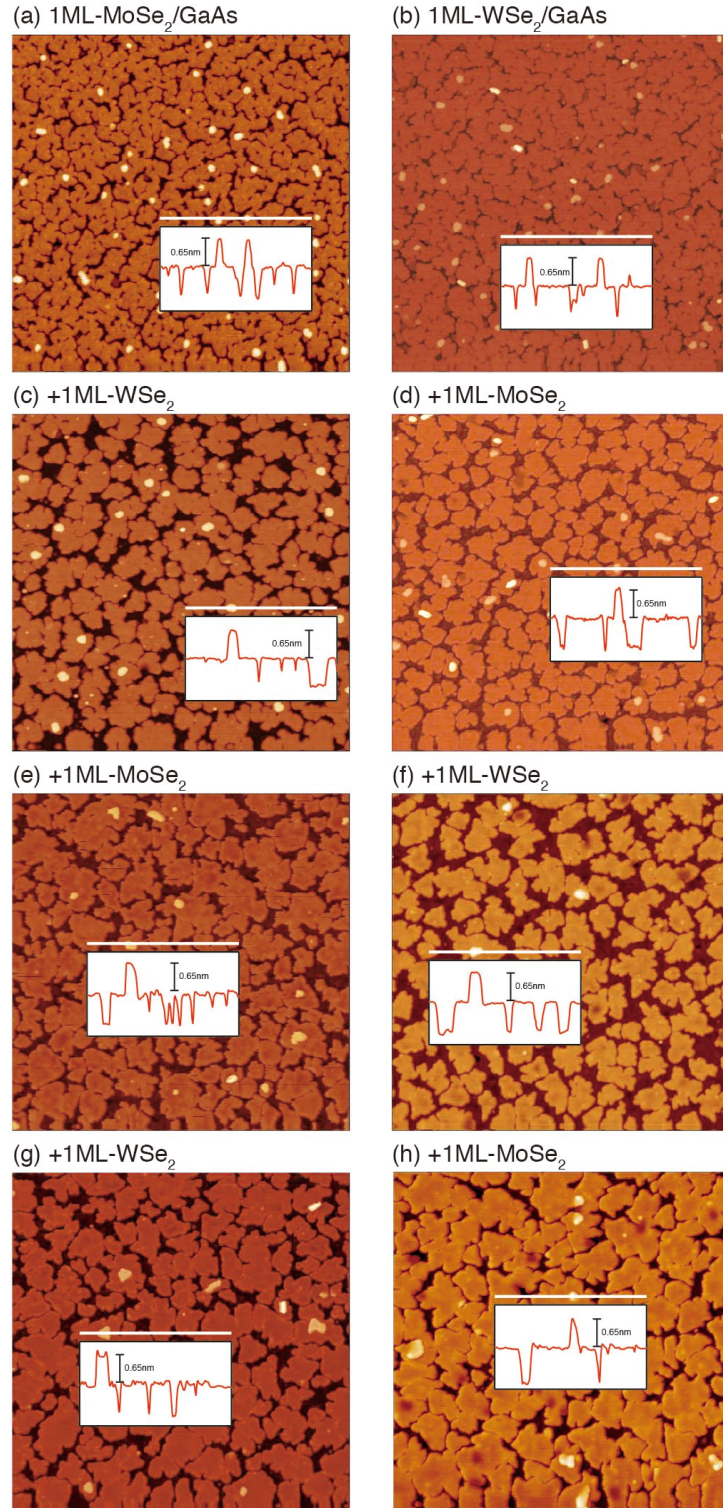
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**Figure S1.** RHEED patterns taken during the growth of MoSe<sub>2</sub> - WSe<sub>2</sub> heterostructures on the Se-treated GaAs(111)B substrates. (a) and (e) were taken from the Se-treated GaAs(111)B-(1x1) substrate. (b) and (f) were taken after the 1st growth of WSe<sub>2</sub> and MoSe<sub>2</sub> monolayers, respectively. (c) and (g) were taken from the MoSe<sub>2</sub> and WSe<sub>2</sub> monolayers, respectively after the annealing. (d) and (h) were taken from the bilayer MoSe<sub>2</sub>/WSe<sub>2</sub> and WSe<sub>2</sub>/MoSe<sub>2</sub> heterostructures after the annealing.



**Figure S2.** A series of STM images observed during the growth of MoSe<sub>2</sub>/WSe<sub>2</sub> and WSe<sub>2</sub>/MoSe<sub>2</sub> heterostructures on Se-treated GaAs(111)B substrates. Image dimensions are 200 nm x 200 nm. The insets show the height profiles along the white lines.