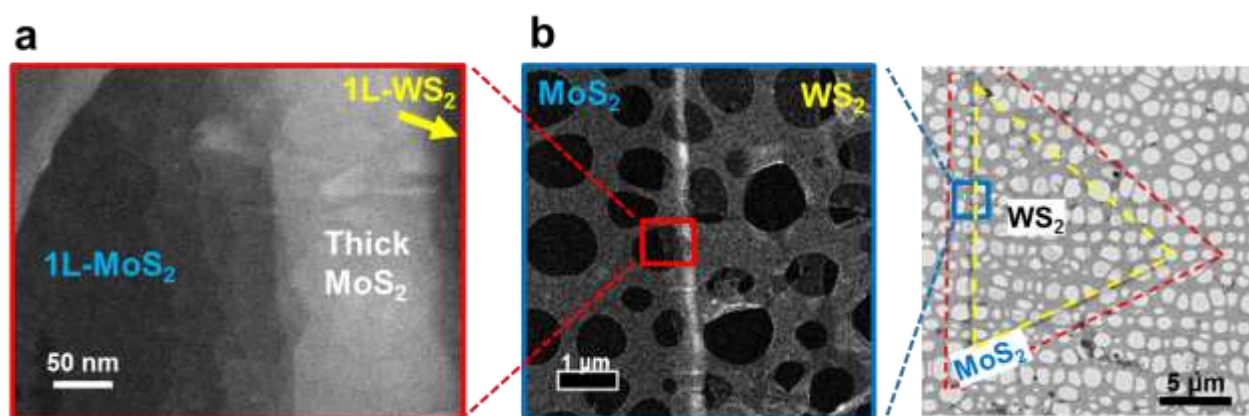




**Supplementary Figure 1.** TEM image of the lateral WS<sub>2</sub>-MoS<sub>2</sub> heterojunction with “rough” interface. **a** High-resolution TEM image indicates stacks of MoS<sub>2</sub> formed at the interface area. **b** Low magnification TEM image clearly shows that MoS<sub>2</sub> stacks are distributed over the entire heterojunction. The yellow dashed lines denote the boundary between WS<sub>2</sub>-MoS<sub>2</sub>.

### Supplementary Note 1

The rough interface of a WS<sub>2</sub>-MoS<sub>2</sub> lateral heterostructure (LHS) grown by the two-step growth process is investigated via transmission electron microscope (TEM) as shown in Supplementary Figure. 1. Stacks of small MoS<sub>2</sub> flakes are formed over the entire heterojunction. The number of stacks varies depending on details of the growth conditions and it can be tens of layers.