Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information for

Selective and confined growth of transition metal dichalcogenides on transferred graphene

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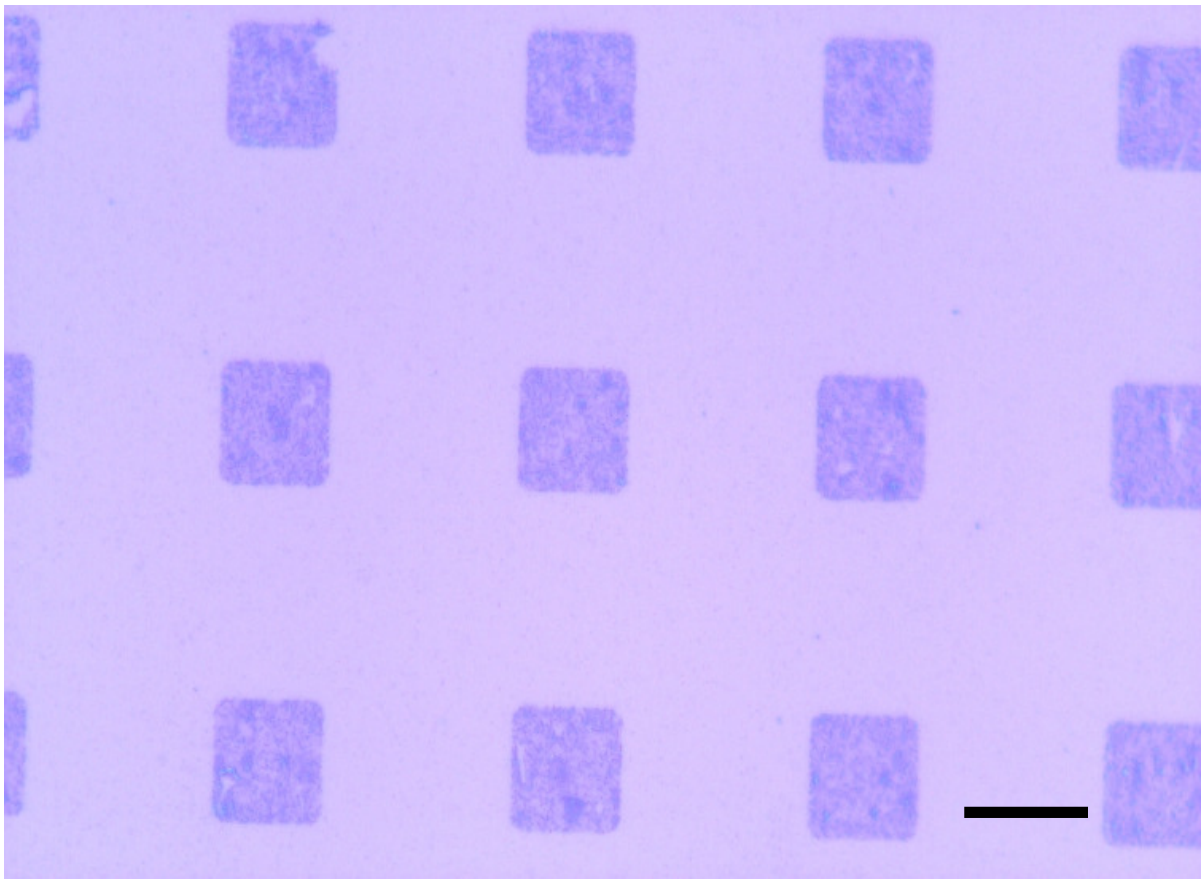

Figure S1: Additional optical micrograph of MoS_2 on patterned graphene. Scale bar corresponds to 20 µm.

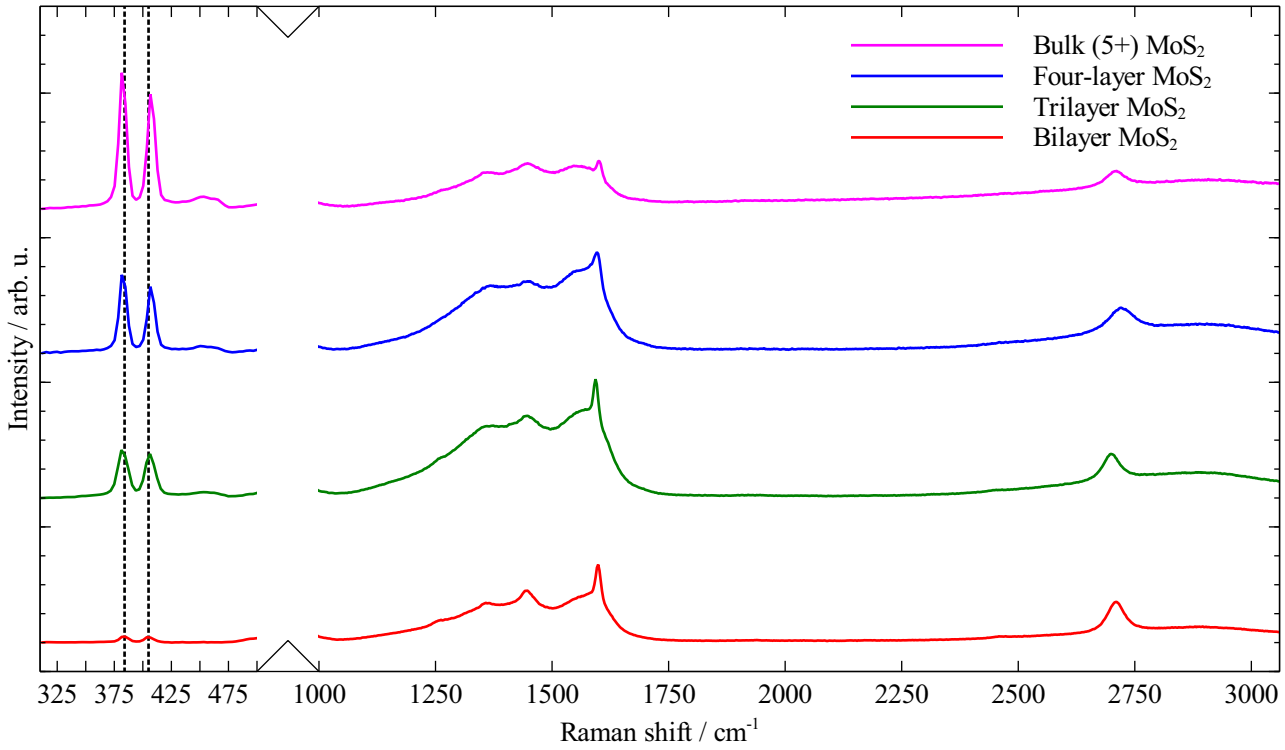

Figure S2: Raman spectrum of MoS_2 on graphene ranging from bilayer to bulk (5+ layers).

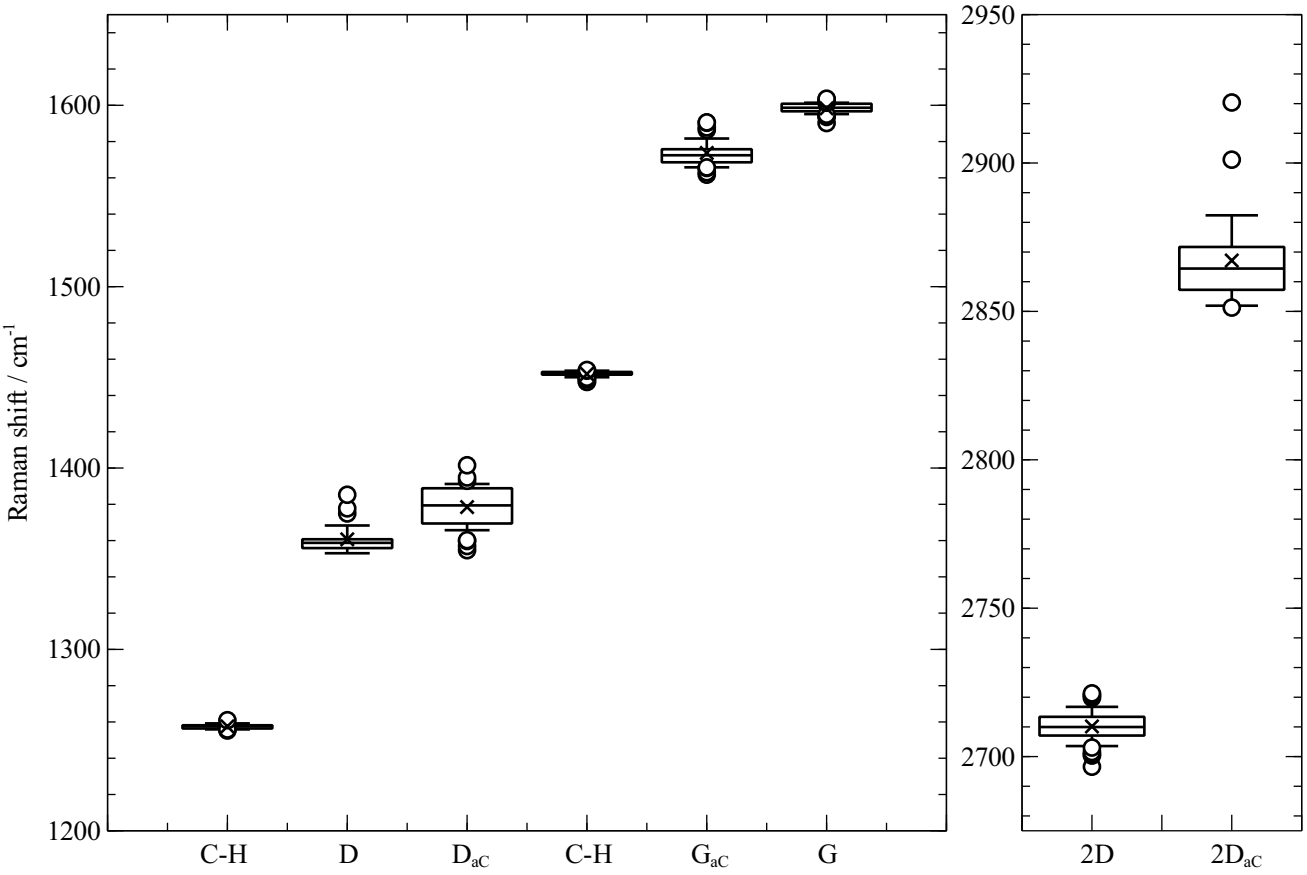

Figure S3: Statistical dispersion of Raman peak positions based on fitting of multiple (N = 24) MoS_2-on-graphene Raman spectra. Cross indicates mean position, box indicates the upper and lower quartiles, and the whiskers denote the standard deviation. Circles indicate outliers.

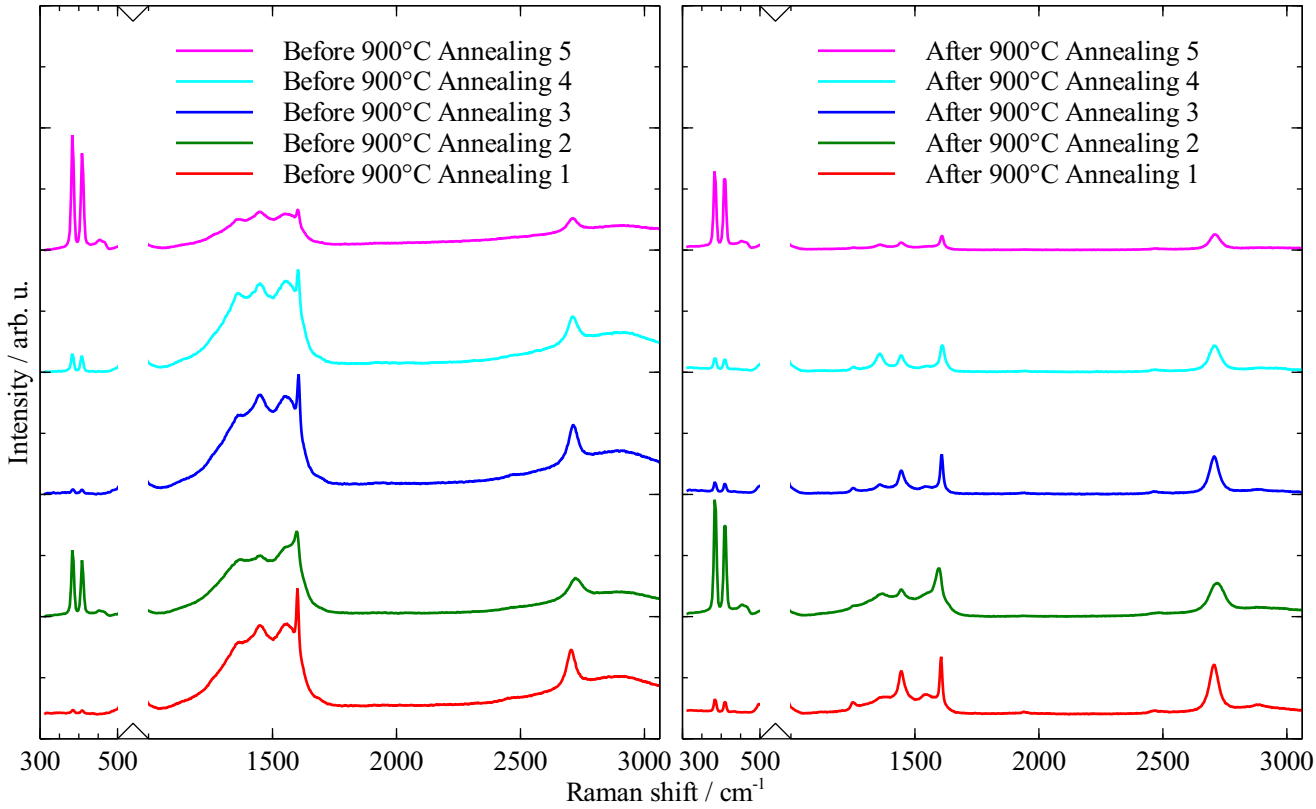

Figure S4: Left panel: Raman spectra of MoS_2 grown on graphene. Right panel: Raman spectra of MoS_2-on-graphene after annealing in sulfur environment at 900 °C. Spectra in left and right panels were taken at the same positions.

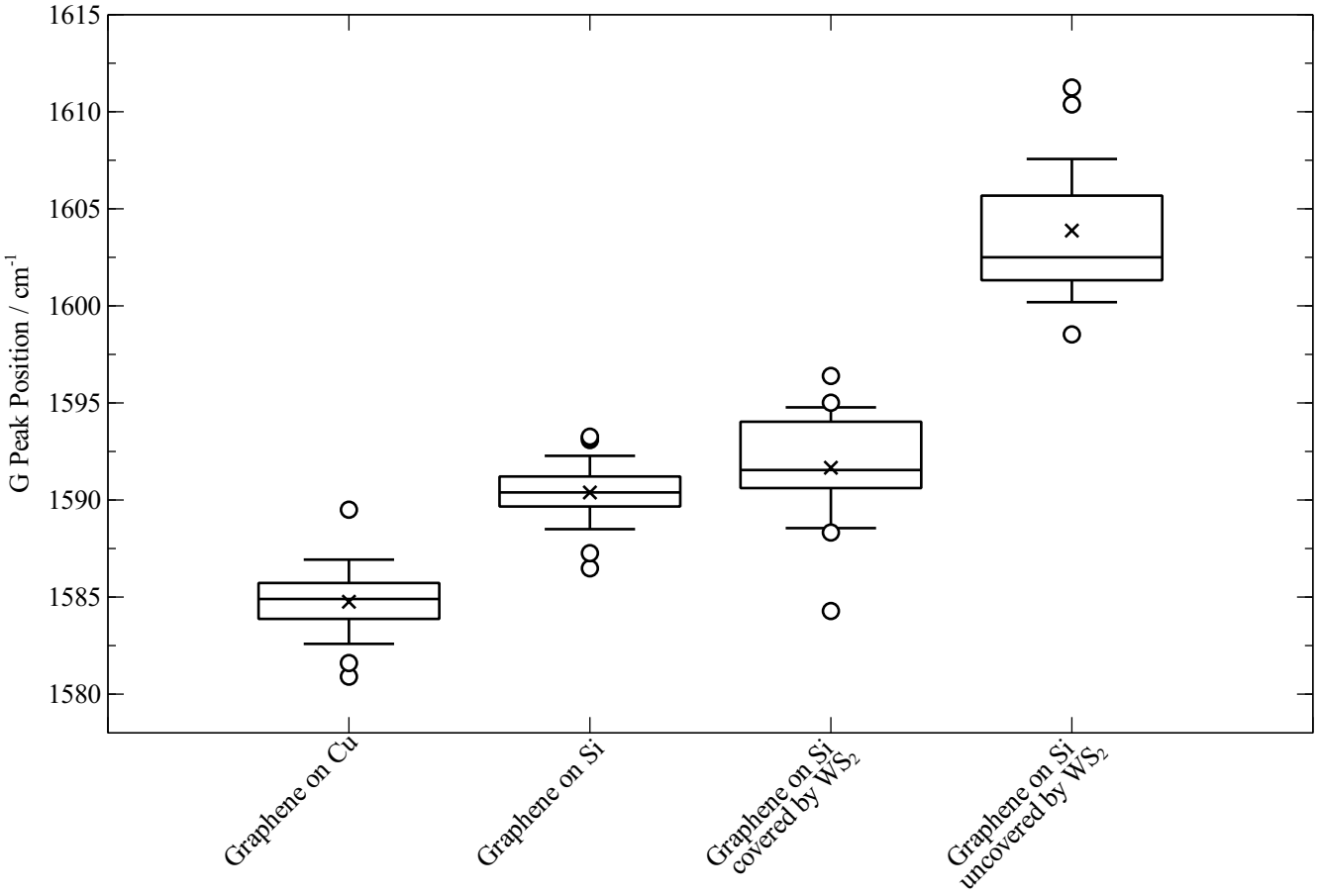

Figure S5: Box plot of Raman G peak position at different stages of WS_2-on-graphene growth process. Upshift indicates doping level, which is significant for graphene after WS_2 CVD, but not covered by WS_2. $N = 12$

The graphene G peak shifts when doping level in graphene increases. Therefore, the G peak position can be used to determine the doping level of graphene qualitatively. These spectra show graphene is more p-doped after transfer from copper to silicon substrate. However, the doping level of WS_2-covered graphene after CVD of WS_2 is only slightly higher than graphene transferred onto silicon. The doping level of graphene not covered by WS_2 after CVD is much higher than the graphene covered by WS_2.

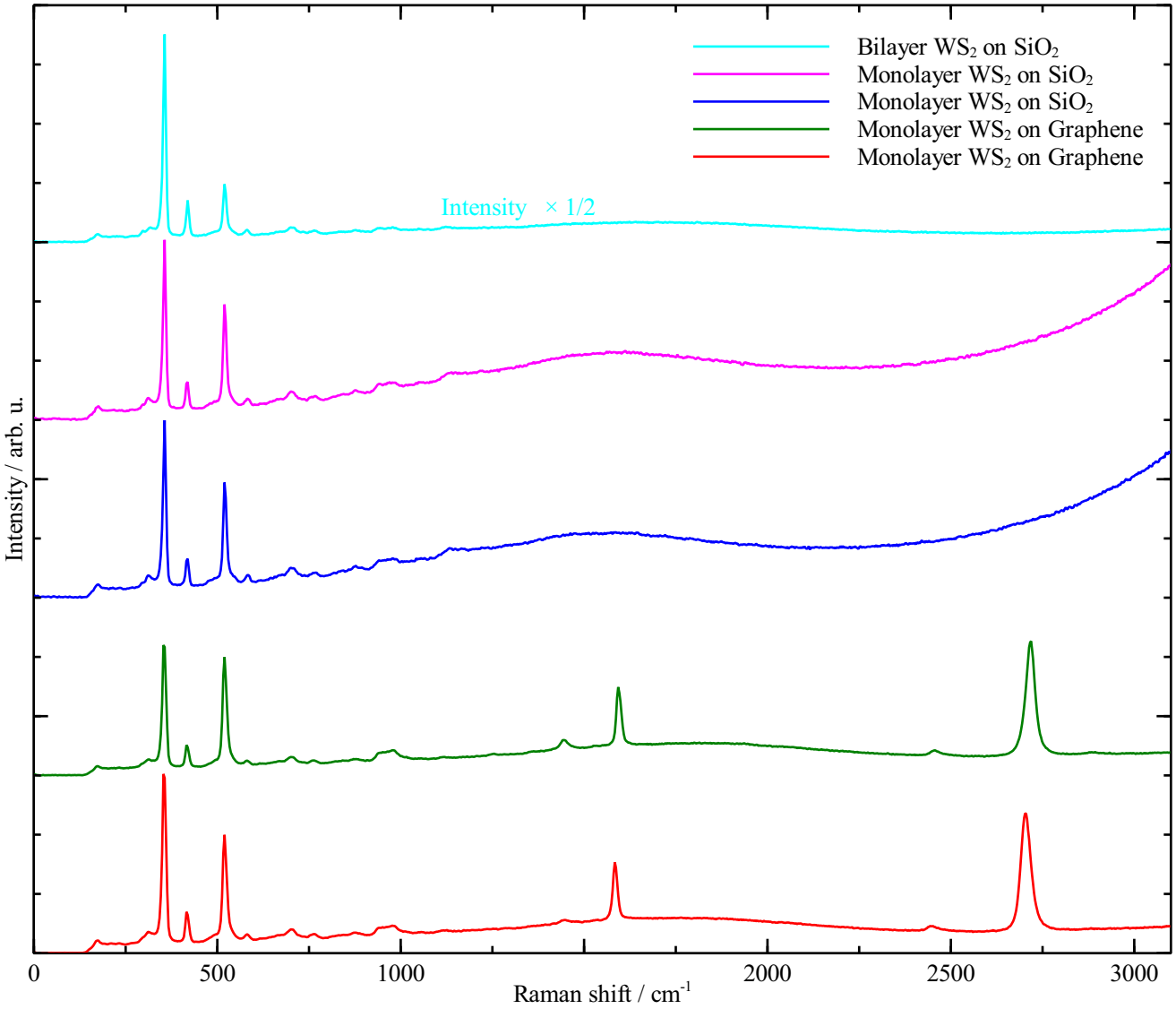

Figure S6: Onset of fluorescence tail near 3000 cm^{-1} offer additional evidence that identification of monolayer WS_2 is correct.

The origin of fluorescence tail is the direct band gap in monolayer (ML) WS_2. Because there is an energy difference between the 488 nm laser source and the ML WS_2 band gap, a broad fluorescence peak can be generated around 4700 cm^{-1}. The tail of this peak can be found seen near 3000 cm^{-1} in Raman spectra.

Emission is quenched in bilayer WS_2 on silicon, because the direct band gap in ML WS_2 is replaced by an indirect band gap. Emission is also quenched for ML WS_2 on graphene, due to the fast charge transfer to graphene.[S1]

References

[S1] J. He, N. Kumar, M. Z. Bellus, H.-Y. Chiu, D. He, Y. Wang, H. Zhao. *Nat Commun* **2014**, *5* 5622.