All-Chemical-Vapor-Deposition of Ternary MoS_2/WS_2/Graphene Vertical van der Waals Heterostructures

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Van der Waals heterostructures (vdWHS) [1] provide a unique playground to study fundamental physics and practical applications of two-dimensional (2D) materials. Today, however, most 2D heterostructures are prepared by transfer, and only simple, binary stacks are grown by chemical vapor deposition (CVD) [2].
Here, we report the all-CVD growth of ternary MoS_2/WS_2/graphene vertical vdWHS without transfer step [3]. By atomic force microscopy, photoluminescence, Raman spectroscopy, and secondary ion mass spectroscopy, we confirm the vertical stacking of three different monolayer 2D materials, indicating the quality of the underlying layers is preserved after the growth runs. Optical studies revealed that while we observe the interlayer exciton in MoS_2/WS_2 heterostructure, it is quenched in MoS_2/WS_2/graphene due to the conductive graphene layer. Finally, the MoS_2/WS_2/graphene-based device shows the potential of being used as a photoresponsive memory device.
These results demonstrate the applicability of ternary all-CVD vdWHS and pave the way for the growth of more complex 2D heterostacks.

References

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Figures

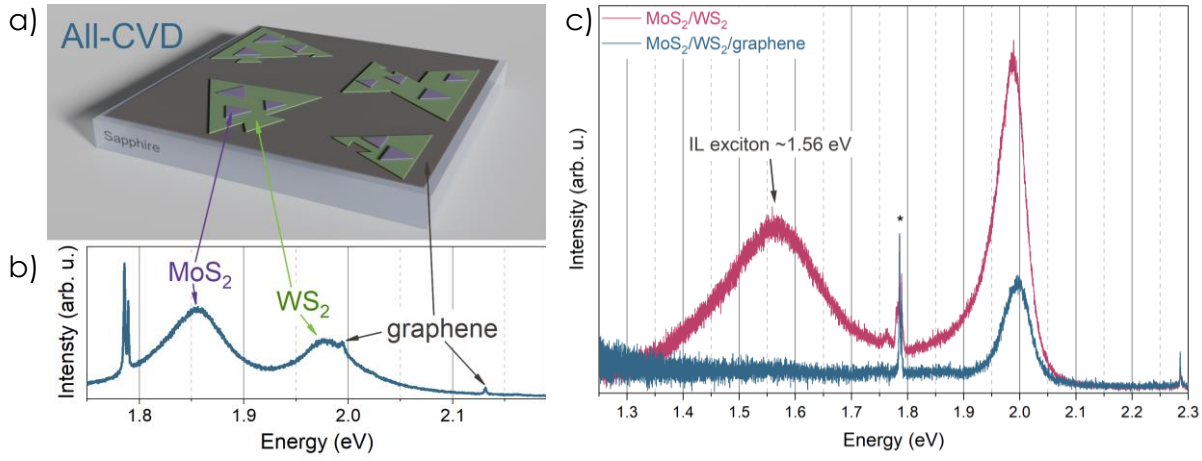

Figure 1: a) Schematic representation of the ternary heterostructure; b) photoluminescence spectrum of the ternary heterostructure; c) comparison between MoS_2/WS_2 and MoS_2/WS_2/graphene showing lack of interlayer (IL) exciton in the latter.