Property Modification of Two-dimensional Materials Integrated with Self-assembled Nano-supporters

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Abstract

Two-dimensional semiconductors are recently expected to replace bulk-based semiconducting materials based on possibility of perfect elimination of short channel effect (SCE). [1] However, intrinsic oversensitivity of atomically thin material arises the major challenge of substrate effects removal. The previous researches have achieved elimination of substrate influences, however, still remain limitations for practical use of materials. [2, 3]

We report reliable and facile suspending platform for 2D materials using generation of energetically unfavorable environment for supported 2D materials not to be fitted on the substrate geometry. The substrate were facilitated by high frequency support structures (HFSS) derived by self-assembly of block copolymer. [4, 5] Geometry of suspended monolayer MoS_2 is confirmed by cross-sectional transmission electron microscopy, and it is found that MoS_2 is successfully separated from basal plane. It is also found that the HFSS is more desirable to float the 2D material than the low frequency support structure (LFSS). Influence of substrate elimination to the MoS_2 is determined by optical and electrical analysis. A suspended monolayer MoS_2 results in dramatic enhancement of emission (8.7 times of PL intensity) and electron transport properties (4.3 times of mobility) that are comparable to those of the previously reported MoS_2 on h-BN. [3] In addition, our suspended architecture shows ultimate stability and compatibility with the complex device architecture that has been impossible to be fabricated by fully-suspended architecture. Based on high versatility, the proposed process is also expected to be applicable for various two-dimensional device system.

References

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Figures

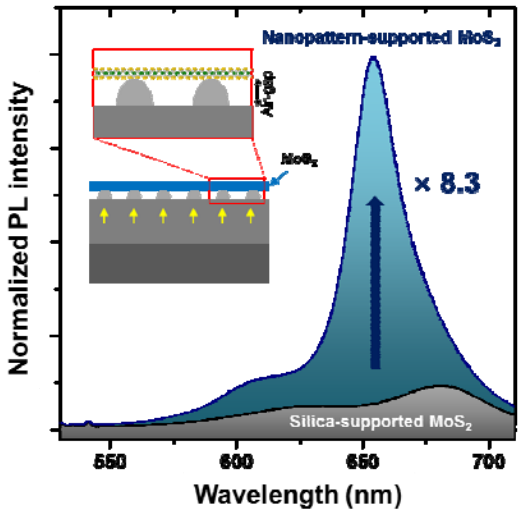

Figure 1: Modulated PL spectra of monolayer MoS_2 using self-assembled nano-supporters. Suspended architecture is schematically presented in the inset of figure.