Lateral Heterostructure of Graphene and MoS_2 for Performance Enhancement of MoS_2 FET

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We report the synthesis of graphene-MoS_2 lateral heterostructure and its utility in the perspective of field effect mobility. To achieve a lateral heterostructure of graphene and MoS_2, ICP-CVD grown single-layer graphene film was transferred onto SiO_2/Si substrate using metal-etching-free transfer process[1], followed by photolithography for its patterning. Subsequently, MoS_2 was synthesized by a CVD method using powder precursors at atmospheric pressure. During the successive annealing for the synthesis of MoS_2 in the presence of the patterned graphene, passivated edges of graphene were reactivated[2] and predominately acted as nucleation sites for MoS_2.

Because lateral growth of MoS_2 from graphene edges should follow kinetic control[3], MoS_2 was synthesized at relatively low temperature, where the vertical growth of MoS_2 on graphene was suppressed due to a large activation energy. We interpret this growth aspect of MoS_2 from graphene edge in terms of a growth mechanism based on classical nucleation kinetics.

We fabricated MoS_2 FETs with graphene source/drain electrodes from the lateral heterostructure. The FETs based on graphene-MoS_2 heterostructure show 5.2 times and 1.3 times increased field effect mobility, in comparison with as-grown MoS_2 and transferred MoS_2 FETs, respectively.

References

[1] Sang Yoon Yang et al., Small, 2 (2015) 175-181

[2] Kun Chen et al., ACS Nano, 10 (2015) 9868-9876

[3] Anupum Pant et al., Nanoscale, 7 (2016) 3870-3887

Figures

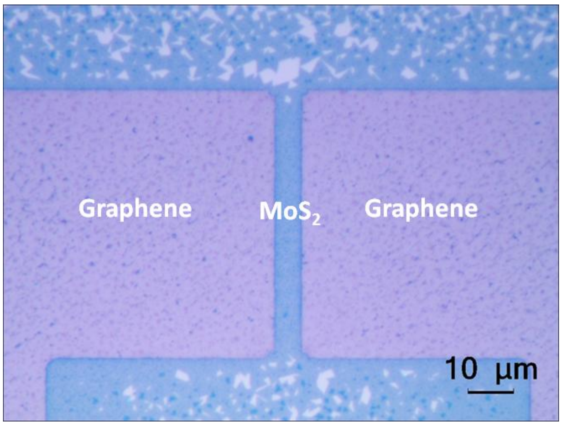

Figure 1: Optical image of synthesized graphene-MoS_2 heterostructure via CVD

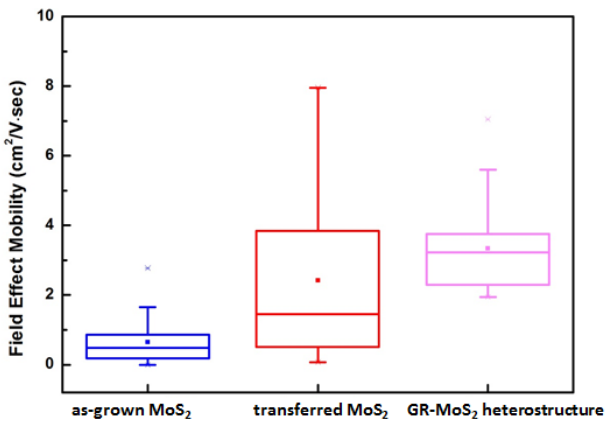

Figure 2: Field effect mobility from various types of MoS_2 channel