Lateral Heterostructure of Graphene and MoS$_2$ for Performance Enhancement of MoS$_2$ FET

Woonggi Hong$^1$
Gi Woong Shim$^1$, Sang Yoon Yang$^1$, Dae Yool Jung$^1$, and Sung-Yool Choi$^1$*

$^1$School of Electrical Engineering, Graphene/2D Materials Research Center, KAIST, 291 Daehak-ro, Yuseong-gu, Daejeon, 34141, Korea

sungyool.choi@kaist.ac.kr

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


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