Enhanced Top-gate Monolayer MoS_2 Transistor Using iCVD Based High-k Dielectric

SeoHak Park[1]
SangHun Lee[1], Woonggi Hong[1], and Sung-Yool Choi[1*]
[1]*School of Electrical Engineering, Graphene/2D Materials Research Center, Center for Advanced Materials Discovery towards 3D Displays, KAIST, 291 Daehakro Yuseong-gu, Daejeon 34141, South Korea.*
psh851416@kaist.ac.kr

Abstract

Because of the dangling bond free nature of 2D-channel materials, 2D-materials based transistor shows incongruity with a conventional ALD dielectric deposition process. Especially 2D-materials based transistors generally show inferior characteristic when they are applied in a form of top gate transistor. [1] In this study, by applying a newly invented initiated chemical deposition(iCVD) process based high-k dielectric p(HEMA)-g-AlO_X as a top gate insulator of MoS_2 transistor, high performance top gate monolayer MoS_2 transistor with mobility of $12 cm^2V^{-1}s^{-1}$, SS of $135 mVdec^{-1}$ with low hysteresis(<100mV) value is developed. [2] With systematic analyses, we could confirm that the reason for this improvement is due to a less coulombic scattering effect and a less surface optical phonon scattering effect of a hybrid dielectric based top-gate MoS_2 transistor than those of Al_2O_3 dielectric based top-gate device.

References

[1] Subhamoy Ghatak et al., ACS Nano, 5 (2011) 7707-7712.
[2] L. Yu et al., IEDM, 32 (2015) 1-4.

Figures

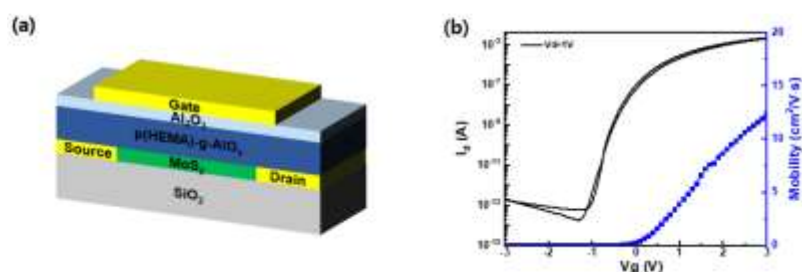

Figure 1: (a) Schematic illustration of fabricated device. (b) transfer characteristic of p(HEMA)-g AlO_x/MoS_2 top-gate device.

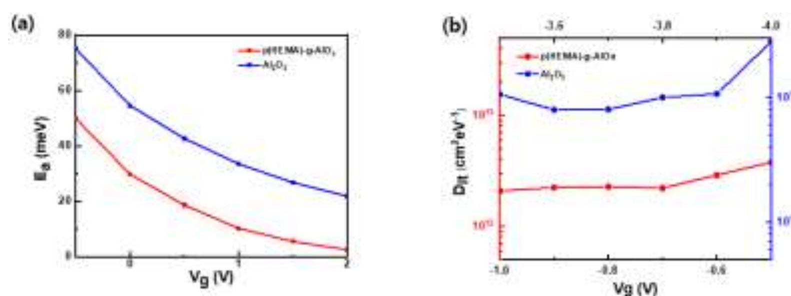

Figure 2: (a) Comparison of activation energy between Al2O3/MoS2 top-gate device and p(HEMA)-g-AlO_x/MoS_2 top-gate device. (b) Difference of interface trap density (D_{it}) for each applied dielectric film.