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Title of the Presentation: Dielectric Engineering for Enhanced Top gate Monolayer MoS_2 Transistor Using iCVD-based High-k Dielectric

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Short Biography:

Seohak Park received his B.S. degree in Information Display(2020) from Kyung Hee University. He is now pursuing a M.S. degree at KAIST under the supervision of Prof. Sung-Yool Choi. His research is focused on engineering of 2D-transistor for advanced future logic and flexible devices.

Abstract:

Transition metal chalcogen compounds have high transparency, flexibility, and excellent electrical properties. Among them, molybdenum disulfide(MoS_2) is widely used as an n-type semiconductor material. In the case of MoS_2, it has a relatively high on-off current ratio, high mobility, and excellent flexibility. However, It shows significantly lower mobility characteristics than its electrical potential because of its poor interfacial characteristic with an insulating layer and a substrate.[1] Particularly, because 2D materials have incongruity with a conventional ALD process due to their dangling bond free surface, 2D materials based transistors generally show inferior interface quality when they are applied in a form of top gate transistor.[2] In this study, by applying a newly invented initiated chemical deposition(iCVD) process based high-k dielectric(pHEMA-g-AlO_X) as a top gate insulator of MoS_2 transistor, high performance top gate monolayer MoS_2 transistor with mobility of $13cm^2V^{-1}s^{-1}$, SS of $135mVdec^{-1}$ and low hysteresis(<100mV) value is developed.[3] Furthermore, it shows more than 5-times higher mobility than a conventional Al_2O_3 insulator-based top gate monolayer MoS_2 transistor. Systematic analyses show 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.

[1]Subhamoy Ghatak et al., ACS Nano 5, 10, 7707-7712 (2011).
[2]L. Yu et al., IEDM 32, 3, 1-4 (2015).
[3]M. J. Kim et al., ACS Appl. Mater. Interfaces 10, 43, 37326-37334 (2018).

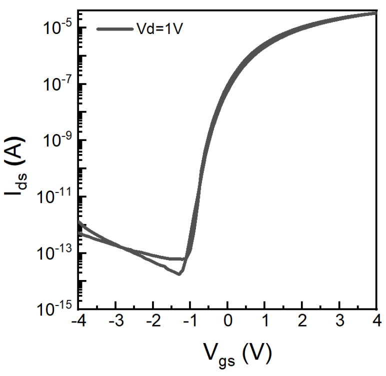

Fig. 1. Transfer characteristic of hybrid dielectric-based top gate 2d-transistor.

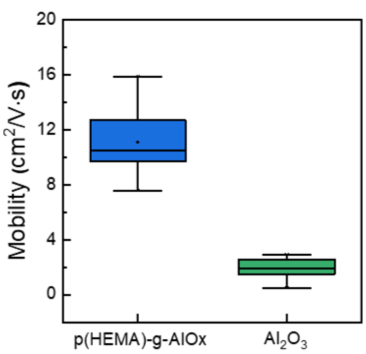

Fig. 2. Comparison of mobility between hybrid dielectric-based and Al_2O_3 dielectric-based top gate 2d-transistor for 10 different devices.