Seongil Im
Yeonsu Jeong, Ji Hoon Park, Yongjae Cho, Hyuckjae Kwon
Yonsei University, Sinchon, Seoul, Korea

semicon@yonsei.ac.kr

Threshold Voltage Adjustment of 2D TMD FETs by Organic Small Molecules

Since transition metal dichalcogenide (TMD) semiconductors are found as two dimensional Van der Waals materials with a discrete energy bandgap, many TMD based field effect transistors (FETs) are reported as prototype devices. But, overall reports indicate that threshold voltage (V_{th}) of those FETs are located much away from 0 V whether the channel is p- or n-type. This definitely causes high switching voltage and unintended OFF-state leakage current. Here, a facile way to simultaneously modulate the V_{th} of both p- and n-channel FETs with TMDs is reported. The deposition of various organic small-molecules on the channel results in charge transfer between the organic molecule and TMD channels. Especially, HAT-CN molecule is found to ideally work for both p- and n-channels, shifting their V_{th} toward 0 V concurrently. As a proof of concept, a complementary metal oxide semiconductor (CMOS) inverter with p-$MoTe_2$ and n-MoS_2 channels shows superior voltage gain and minimal power consumption after HAT-CN deposition, compared to its initial performance. When the same TMD FETs of the CMOS structure are integrated into an OLED pixel circuit for ambipolar switching, the circuit with HAT-CN film demonstrates complete ON/OFF switching of OLED pixel, which was not switched off without HAT-CN.

References

[1] JY Lim et al, Adv. Mater. 29, (2017), 1701798
[2] Y Cho et al, Nano letters 19, (2019), 2456

Figures

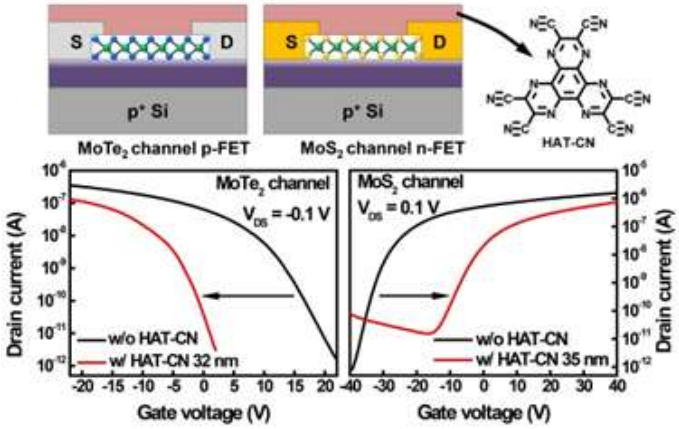

Figure 1: Organic Molecule-Induced Charge Transfer on Operating Voltage Control of Both n-MoS_2 and p-$MoTe_2$ Transistors