7th International Workshop on 2D Materials

Title of the Presentation: A native high- κ gate dielectric for 2D electronics

First Name: Li

Last Name: Tianran

Affiliation: College of Chemistry and Molecular Engineering, Peking University, Beijing, China

Email: litr-cnc@pku.edu.cn

Short Biography:

Tianran Li is a currently a PhD student in College of Chemistry, Peking University. He received his bachelor's degree in Peking University. His research mainly focuses on 2D semiconductors and 2D electronic devices.

Abstract:

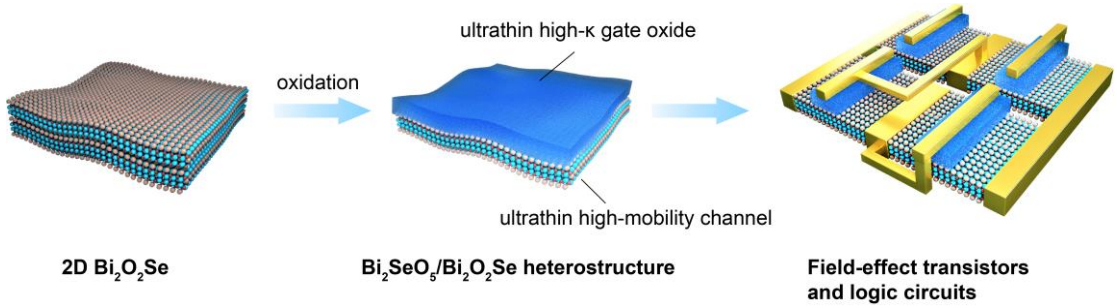

Figure.1 Fabrication of Bi_2O_2Se/Bi_2SeO_5 field-effect transistors and logic circuits

The success of silicon as a dominant semiconductor in electronic industry largely owes to its native oxide counterpart, silicon dioxide. Synthesized simply by heating silicon wafer in oxygen atmosphere, SiO2 is highly dense, uniform and insulative and thus plays a very important role in all kinds of nanoelectronics devices. However, with the mainstream CMOS processing approaching sub-5 nm node, it became increasingly clear that Si/SiO2 system is coming to an end, as SiO2 has a far too low dielectric constant (ε = 3.9).

Recently, we found the native oxide of high-mobility two-dimensional Bi_2O_2Se, Bi_2SeO_5, embodies both high interfacial quality and large dielectric constant. First-principle calculations showed that these two materials and form a typical type I heterojunction with band offset at both CBM and VBM larger than 1 eV, which is most suitable for field-effect devices. These transistors are fabricated with regional-selective etching and microfabrication techniques, showing carrier mobility > 300 $cm^2V^{-1}s^{-1}$, Ion/Ioff ~ 10^6, near-ideal subthreshold swing (SS < 75 mV/dec) as well as much reduced transfer curve hysteresis. Most importantly, effect oxide thickness (EOT) of these FETs can be as small as 0.9 nm, with gate leakage much smaller than thermal SiO2 of similar EOT. The inverter circuits constructed by these FETs have a maximum voltage gain >150 at V_{dd} = 1 V. Combined the ultra-thin planar structure of 2D materials and their natural resistance to short-channel effect, this material system can break through the bottleneck of modern electronic industry, and hopefully extend Moore's Law.

[1] Li, T. et al., *Nat*. *Electron*. 3, 473-478 (2020).

[2]Tu, T. et al., *Nano Lett*. 20, 7469-7475 (2020).