Chemically Functionalized Top-contact Electrodes: Boosting the Performance of MoS_2 Field-Effect Transistors by Tuning the Charge Injection

Bin Han, Yuda Zhao, Chun Ma, Can Wang, Xinzi Tian, Ye Wang, Wenping Hu, Paolo Samorì*

Université de Strasbourg, CNRS, ISIS. 8 allée Gaspard Monge, 67000 Strasbourg, France
E-mail: samori@unistra.fr

The interface between electrodes and semiconductors plays a critical role in the (opto-)electronic performance of devices based on ultrathin two-dimensional layered materials. Unfortunately, a lack of interfacial modulation in the top-contact configuration impedes the performance of these devices. Here, we propose a contact engineering method to functionalize the electrodes of top-contact field-effect transistors (FETs) by transferring chemically pre-modified electrodes. We systematically tuned the electrodes of molybdenum disulfide (MoS_2)-based FETs using conventional thiol molecules with different dipoles. Notably, we observed significant improvements in device performance when we modified the Au electrode with electron-donating molecules. Using this facile approach, we fabricated a high-performance Schottky diode with asymmetrically functionalized electrodes by utilizing dipole-opposed molecules on two electrodes, resulting in a rectification ratio of ~10^3. Our results demonstrate a powerful and unprecedented strategy for tuning the interfacial properties in top-contact MoS2 FETs and tailoring device performance on demand.

References

[1] B. Han, Y. Zhao, C. Ma, C. Wang, X. Tian, Y. Wang, W. Hu, P. Samorì, Adv. Mater. 2022, 2109445.
[2] Y. Liu, J. Guo, E. Zhu, L. Liao, S.-J. Lee, M. Ding, I. Shakir, V. Gambin, Y. Huang, X. Duan, Nature 557(2018), 696.
[3] S. Casalini, C. A. Bortolotti, F. Leonardi, F. Biscarini, Chem. Soc. Rev. 46 (2017), 40.

Figures

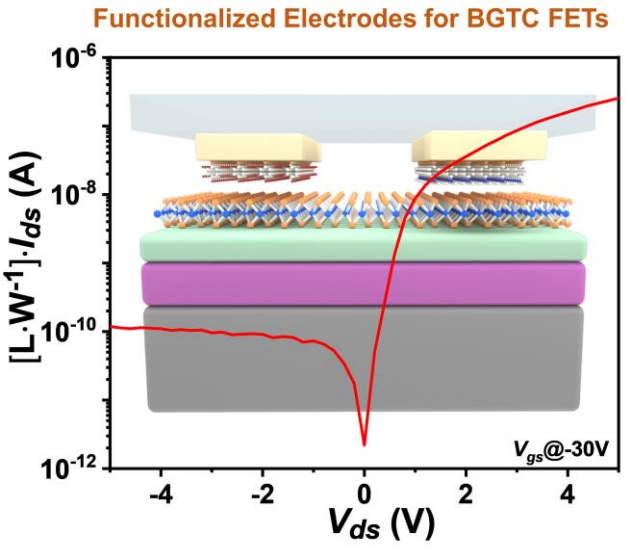

Figure 1: Schematic diagram and the output curve of asymmetric MoS_2 FETs device with electrodes functionalized by PFBT and DABT respectively.