Tnano 2020

International Workshop on Nanotechnology (Tnano20)
October 5 – 8, 2020, in Tbilisi, Georgia

2D VAN DER WAALS HETEROSTRUCTURES FOR EMERGING DEVICE APPLICATIONS

Feng MIAO

School of Physics, Nanjing University, Nanjing, China
miao@nju.edu.cn

Van der Waals (vdW) heterostructures are formed by stacking layers of different 2D materials and offer the possibilities to design new structures with atomic-level precision. In this talk, I will show how these heterostructures provide unprecedented opportunities to realize emerging device applications, especially in the fields of memory, computing and advanced optoelectronics.

I will first show that robust memristors with good thermal stability, which is lacking in traditional memristors, can be created from a vdW heterostructure composed of graphene/$MoS_{2-x}O_x$/graphene. The devices exhibit excellent memory performance with an endurance of up to 10^7 and a high operating temperature of up to 340 °C. With the help of *in situ* electron microscopy, we revealed the origin of good thermal stability and a possible switching mechanism.**[1]** We also observed ballistic avalanche phenomena in a thin vdW heterostructure made of black phosphorus and Indium Selenide (InSe). Such phenomena can be utilized to realize efficient carrier manipulation and develop advanced optoelectronic devices. **[2]** Our latest results on a gate-tunable vdW heterostructure for reconfigurable neural network vision sensor, as well as an electrically tunable homojunction for reconfigurable logic and neuromorphic circuits will also be presented. **[3, 4]**

References

[1] M. Wang *et al.*, "Robust memristors based on layered two-dimensional materials", *Nature Electronics* **1**, 130 (2018).

[2] A. Gao *et al.*, "Observation of ballistic avalanche phenomena in nanoscale vertical InSe/BP heterostructures", *Nature Nano.* **14**, 217 (2019).

[3] C. Wang *et al.*, "Gate-tunable van der Waals heterostructure for reconfigurable neural network vision sensor", *Science Advances* **6**, eaba6173 (2020).

[4] C. Pan *et al.*, "Reconfigurable logic and neuromorphic circuits based on electrically tunable two-dimensional homojunctions", *Nature Electronics* (2020).