Tuning Properties of 2D Materials and Defect Engineering

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Abstract

Current semiconductor industry is facing a limit of scaling. Thus, it is urgent to find a new type of material to replace Si. Two-dimensional (2D) materials, especially those with a proper band gap provide a solution to this problem since the thickness of a monolayer of 2D materials can be reduced to only few atoms. Scanning tunneling microscopy (STM) is a powerful method to reveal both the geometry and electronic structure down to atomic scale. In this presentation, I will discuss several issues of 2D materials and devices studied by STM. First, the defect induced mobility modulation in 2D devices is visualized by STM. It is clear that STM can provide vital information for helping the developments of 2D materials and devices [1]. Second, a two-step method to reduce 99% surface defects of transition metal dichalcogenides (TMDs) is found [2]. Finally, we demonstrated a bandgap engineering technique in two monolayer materials, MoS_2 and $PtTe_2$, with the tunneling current as a control parameter [3]. The bandgap of monolayer MoS_2 decreases logarithmically by the increasing tunneling current. Monolayer $PtTe_2$, by contrast, exhibits a much stronger gap reduction, and a reversible semiconductor-to-metal transition occurs at a moderate tunneling current.

[1] Chen et al., Appl. Phys. Lett. 121, 151601 (2022). [2] Chen et al., ACS Appl. Mater. Interfaces, 15, 12, (2023). [3] Lin et al., ACS Nano 16, 14918–14924 (2022).