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Voltage induced phase engineering in MoS_2/GFNO heterostructure

Owing to the nature of the metal/TMD interface, the contact geometry and energy level permutation play a key role in determining metal/TMD resistance [1][2]. Although the simulation shows zero Schottky barrier contacts with the 2H-1T' phase engineering [3], phase transition in MoS_2 have been only induced by thermal or chemical doping [4] [5][6]. It still lacks reliable methods to control the phase transition of MoS_2. In this work, we come across the idea using ferroelectric-driven phase transition on the MoS_2/GFNO heterostructures (Figure.1). We find that the 2H-1T' phase transition shows a reversible and hysteretic loop in Raman spectra during electrical manipulation (Figure 2). we distinguish the vacancy and structure transition by Scanning Photoelectron Microscopy (SPEM) and μ-PES (Figure 3, Figure 4), the shift only happened in Mo 3d spectrum suggest the sulfur vacancy generate during annealing process; in addition, the surface potential of GFNO will be controlled after pulse-voltage applying, therefor, the binding energy (Mo 3d, S 2p, Gd 4f) shift simultaneously which is due to the different symmetric of d-orbital splitting in 2H and 1T'phase. The vacancy and ferroelectric induced phase transition were investigated by the core-level shift via scanning photoelectron microscopy. The ferroelectric control on the structural phase transition opens up possibilities for developing ferroelectric based devices such as 2D non-volatile memory devices or 2D NCFET devices.

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References

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Figures

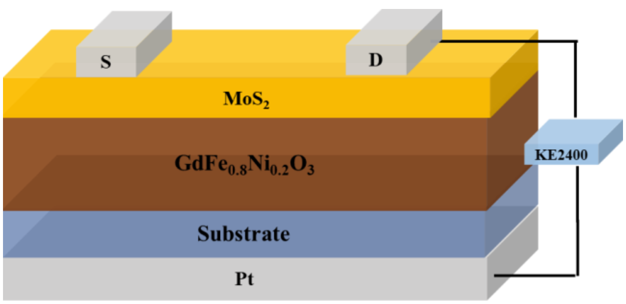

Figure 1: Device schematic of the 2D $MoS_2/GdFeNiO_3$ heterostructure

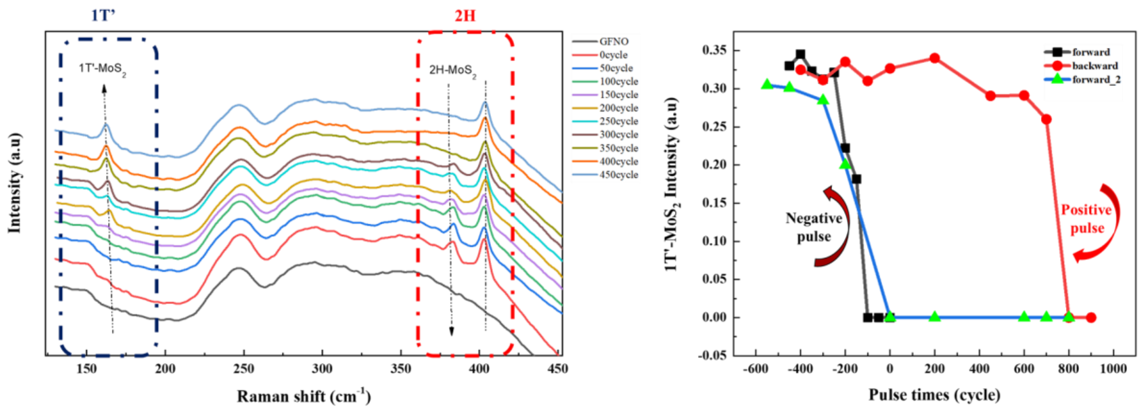

Figure 2: (Left) In-situ bias depend Raman spectrum (Right) Intensity ratio of 1T' Raman spectrum

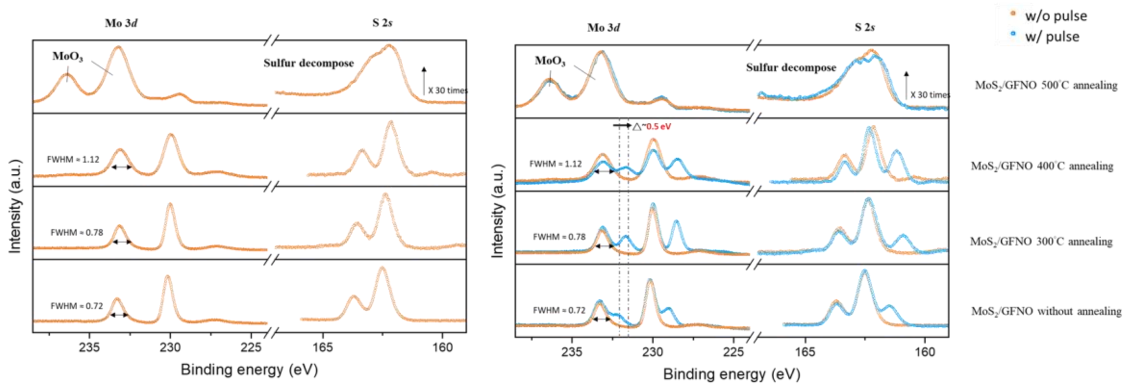

Figure 3: X-ray photoemission spectra of Mo 3*d*, S 2*s*, and S 2*p* core-level. (left) For MoS_2 on GFNO film annealed at various temperatures; (right) ex-situ pulse voltage applied after annealing.

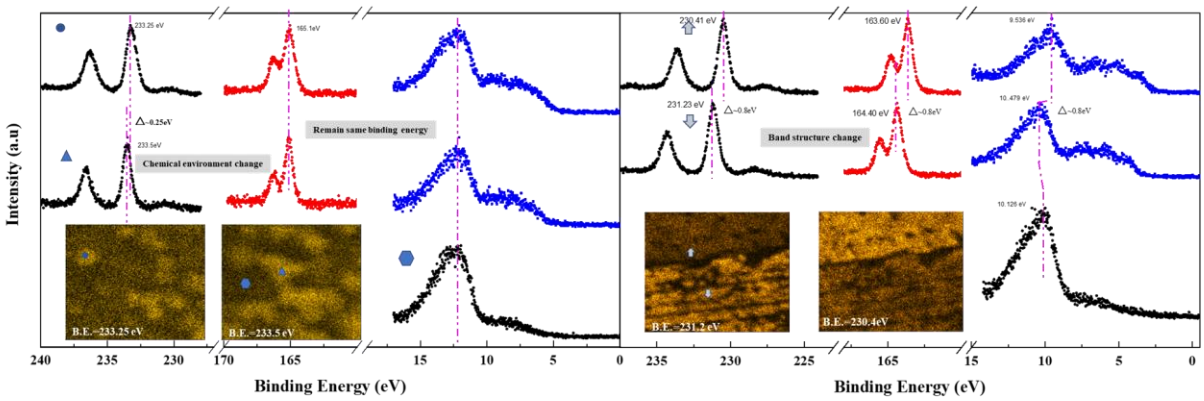

Figure 4: SPEM images and μ-PES measurements on the MoS_2/GFNO homojunction. Mo 3d, S 2s, S 2p and Gd 4f core-level photoelectron spectra measured with SPEM. (left) For MoS_2 on GFNO film annealed at various temperatures; (right) Pulse voltage applied after annealing for MoS_2/ GFNO heterostructure.