Topological phase transition in bilayer WSe_2/III-V heterostructure

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Molecular beam epitaxy (MBE) growth of bilayers two-dimensional (2D) materials on conventional 3D semiconductors gives rise to 2D/3D quasi-van der Waals heterostructures. The importance of these heterostructures depends on the properties of the 2D material used. Thus, the stacking and crystalline structure of the bilayer is an important factor that needs investigation. We report a direct observation of a controllable phase transition in bilayer tungsten diselenide (WSe_2) on GaP(111) heterostructure induced by annealing temperature. The crystalline structures of 3R stacking bilayer accompanied by 1T' phase and the 2H phase were characterized using reflection high energy electron diffraction (RHEED). The phase transition mechanism is confirmed using the electronic properties by XPS and ARPES. This temperature-induced crystalline phase transition makes the WSe_2 bilayer an ideal platform for controlling topological phase transitions in 2D materials[1-3].

References

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[2] Aymen Mahmoudi, Meryem Bouaziz, Anis Chiot, Gaia Di Berardino, Nathan Ullberg, Geoffroy Kremer, Pavel Dudin, José Avila, Mathieu Silly, Vincent Derycke, Marco Pala, Iann C. Gerber, Julien Chaste, Fabrice Oehler and Abdelkarim Ouerghi, PHYSICAL REVIEW B 108, 045417 (2023).

[3] "Temperature induced phase transition in bilayer WSe_2/GaP heterostructure". Meryem Bouaziz, Aymen Mahmoudi, Niels Chapuis, Fabrice Oehler, Julien Chaste, François Bertran, Iann C.Gerber, Gilles Patriarche, Xavier Wallart, Abdelkarim Ouerghi ; in progress

Figures

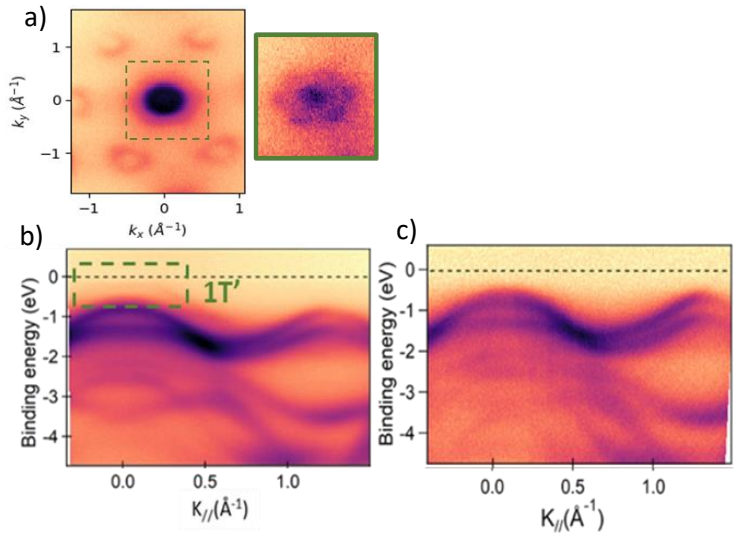

Figure 1: a) Fermi surface of the WSe_2 bilayer showing the Γ point surrounded by the 6 K points. A moiré system can be distinguished in the low-scale image, confirming the 1T' phase. Comparison of the band structure of WSe_2 at low temperature (b)before and(c) after annealing at 600°C, illustrating the transition from metallic 1T'phase to hexagonal 2H phase.