Fabrication of large-area twisted bilayer TMDC moiré superlattice

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Twisted van der Waals hetero-, homo- structures have recently attracted prominent attention for their many remarkable electronic properties, such as superconductivity in twisted bilayer graphene. The flat band which emerged due to moiré superlattice drives their electronic system into the strongly correlated regime, giving us a platform to study various quantum phases of matter [1]. Many experimental efforts have been made so far to clarify their novel electronic structure. However, the structure fabricated by mechanical exfoliation is relatively small, typically less than 0.1 mm, making it difficult to access their property. In this study, we have implemented recently reported large-area mechanical exfoliation techniques [2] and succeeded in fabricating atomically clean WSe_2 twisted homo-bilayer over 1 mm size. Fig.1 shows a photograph of fabricated WSe_2 twisted bilayer on SiO_2/Si substrate. The WSe_2 atomic layers were transferred onto the center part with solid contrast, and its size is 3 mm x 3 mm large enough for the STM experiment. Fig.2 shows the STM topography obtained on bilayer structure transferred onto HOPG substrate. Moiré superlattice with 6 nm periodicity was observed. In addition, an atomically clean surface has been obtained with low defects and contaminants even though we used many chemicals when we exfoliated and transferred the mono-, bi-layer sample, such as a polymer (PMMA), adhesive tape, and etching solution. Finally, we carried out spatially resolved dI/dV measurement below 10 K to map the quantum-confined electronic state induced by moiré potential as shown in fig.3 . In this presentation, we will discuss the details of the exfoliation techniques and the experimental results.

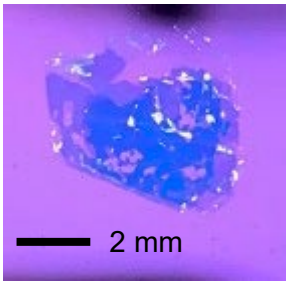

Fig.1. A photograph of WSe_2 twisted bilayer on SiO_2/Si

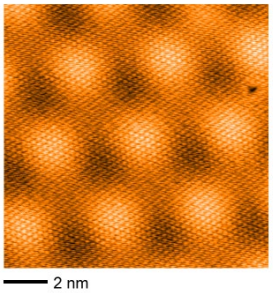

Fig.2. STM topography of WSe_2 twisted bilayer

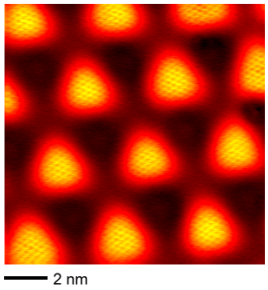

Fig.3. dI/dV image obtained at V_S = -1.4 V

[1] D. M. Kennes, *et al*., Nature Phys, **17**, 155-163 (2021)

[2] F. Liu, *et al*, Science **367**, 903–906 (2016)