Modification of monolayer 1T-VSe_2 by selective deposition of vanadium and tellurium

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Abstract

Hetero-structures of transition metal dichalcogenide (TMD) layers offer vast possibilities of new materials properties. Since TMD hetero-structures have weak van der Waals interlayer interactions, lattice mismatch is less likely a serious constraint. Nonetheless, the growth behaviours of such TMD hetero-structures can be complex and are not well documented. Here, we report an attempt to grown VTe_2/VSe_2 hetero-bilayers using molecular beam epitaxy. STM observation shows several structure modifications of a VSe_2 monolayer by the deposition of either Te, V or both. With a typical growth temperature of 300 ^{0}C and a nominal flux rate, we found Te deposition leaves the VSe_2 intact, with the (√7x√3) characteristic CDW of monolayer VSe_2[1]. Vanadium deposition, in contrast, leads to the formation of small clusters ordered in stripes along VSe_2 lattice close-packed directions. With V and Te co-deposition, a dramatic change of the monolayer surface structure to a (2x1) ordered phase is observed. VSe_2 CDW is found to disappear as a consequence of confinement. This study illustrates the unexpected complexities involved in preparing even a simple bilayer TMD hetero-structure such as VTe_2/VSe_2. Some reasoning of the observed phenomena will be given.

References

[1] P. Chen, W. W. Pai, Y. H. Chan, V. Madhavan, M. Y. Chou, S. K. Mo, A. V. Fedorov and T. C. Chiang, Phys. Rev. Lett., 19 (2018) 196402

Figures

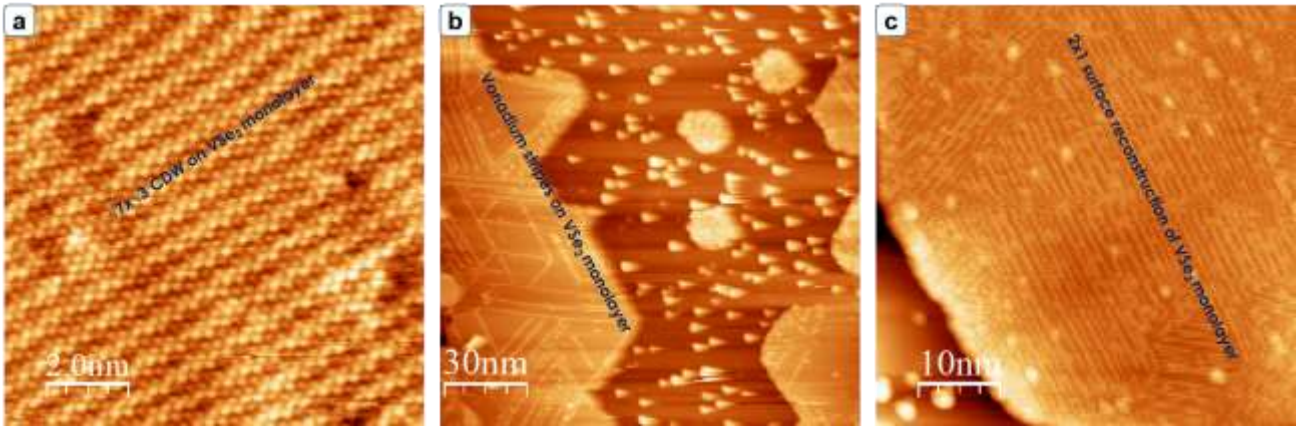

Figure 1: (a) Atomic resolution of characteristic (√7x√3) CDW of 1T-VSe_2 monolayer upon Te deposition. (b) Topography of a VSe_2 monolayer after V deposition. (c) Morphology of the apparently reconstructed VSe_2 island after co-deposition of V and Te flux.