Soutenance de thèse

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Shaping tungsten dichalcogenides properties by chemical vapor deposition of alloys and polytypes

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Abstract

Two-dimensional (2D) transition metal dichalcogenides (TMDs) present varied optical and electronic properties associated with their different crystal structures. We optimize here the chemical vapor deposition (CVD) of tungsten-based TMDs, such as hexagonal (1H) WSe2 and WS2 monolayers, as well as monoclinic (1T') WTe2. While 1H WSe2 and WS2 are typically direct band-gap semiconductors in the monolayer form, the anisotropic 1T' WTe2 is a small band gap topological insulator. Our purpose is to study the structural and electronic phase transition of ternary alloy WSe2xTe2(1-x) between the 1H and 1T' crystal structures. However, the synthesis of the mid-composition (x~0.5) alloys by CVD remains challenging. By just adding an additional monolayer, we obtain bilayer (2ML) structures, in which the available polytypes combinations, and the relative physical properties, are even richer. We further optimize our CVD growth methods to maximize the yield of 2ML hexagonal WSe2 and WS2. In addition to Raman and photoluminescence spectroscopies, we employ various other experimental techniques, including second harmonic generation and selective area electron diffraction, to discern between the 2ML polytypes. We then focus on the 3R bilayer stacking of WSe2 and we resolve its electronic band structure by angle-resolved photoemission spectroscopy.