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Synthesis and characterization of stable 1T WS_2 and its junctions

Transition metal dichalcogenides (TMDCs) in 1T phase have been attracting great research interests due to their potential applications in supercapacitors, electrocatalytic hydrogen evolution, and phase transition memories. The earlier reported method of obtaining 1T WS2 or MoS2 was using solution-based ion intercalation and chemical exfoliation. The chemical exfoliation results in small monolayer flakes with the mixture of 1T and 1T' patches embedded in 2H phase matrix. In this presentation, we will demonstrate a refined growth method to obtain large area monolayer 1T WS2 (~80 μm in size) by using chemical vapour deposition with an aid of synergistic catalysts (iron oxide and sodium chloride). We will also present the discovered distinctive types of phase boundaries at the 1T-2H interface by using scanning transmission electron microscopy (see Figure 1 as an example) [1]. The CVD grown 1T phase is thermodynamically stable on sapphire substrate and can persist at high temperature above 800˚C, allowing for a stepwise edge epitaxy of lateral 1T heterostructures. We will demonstrate the atomic images of the 1T WS2-MoS2 lateral heterojunction with a defect less and sharp atomic transition interface. The optical properties of the WS2 polymorphous were also studied by using Raman and PL mapping with careful STEM confirmation of the corresponding phases. The stable 1T phase WS2 is representing a missing piece of puzzle in the atomic thin TMDCs and may stimulate the further studies in theoretical modelling and also in more practical applications. We acknowledge the support from JSPS-KAKENHI JP16H06333 and 18K14119.

References

[1] Yung-Chang Lin et al., ACS Nano, 12 (2018) 12080-12088

Figures

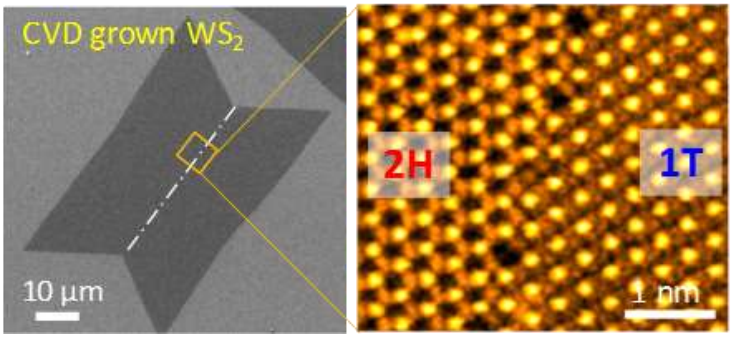

Figure 1: CVD grown WS2 with natural 2H/1T junction.