Observation and Characterization of Biexciton states in high-quality WS₂ Atomic Layers

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1. Introduction
Transition metal dichalcogenides (TMDC, Fig.1) have attracted a great deal of attention because of their unique properties such as spin-valley-coupled electronic structure, valley pseudospin degree of freedom, intense photoluminescence and FET operation. The family of TMDC atomic layers provides a brand new and widespread platform to investigate physics in two-dimension, which platform leads to the promising application in the so-called valleytronics in future. To explore the fascinating possibilities of TMDC, high-quality samples are indispensable. Here, we report a new method for preparing high-quality TMDC using a triple-furnace chemical vapor deposition (CVD) setup and hexagonal boron nitride (hBN) substrates.

2. Results and Discussion
WS₂ have been grown directly onto hBN. The WS₂/hBN synthesized shows excitonic PL emission at 2.01 eV at room temperature, whose linewidth (21.5 meV FWHM at room temperature) and intensity are significantly smaller and stronger, respectively, than those observed in WS₂ grown on other substrates. Temperature dependence of PL spectra of WS₂/hBN is significantly different from those of WS₂ grown on other substrates, where a new peak at 2.016 eV (Fig.2) at 81.6 K appears. As shown in Fig 3, intensity of the new peak can be described by a power-law relation with alpha of 1.53, which suggests that the origin of this new peak due to the presence of biexcitons.

3. Conclusions
We have successfully grown WS₂ by using triple-furnace CVD setup and hBN as a growth substrates. Appearance of the biexciton peak at 80 K clearly demonstrates that the quality of the grown sample is high.[1] The results obtained in this work indicates the importance of substrate in investigation of intrinsic physical properties of TMDC, and further exploration of properties of the present sample is currently underway.

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References