Observation and Characterization of Biexciton states in high-quality WS_2 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 TMDCachi 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

WS_2 have been grown directly onto hBN. The WS_2/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 WS_2 grown on other substrates. Temperature dependence of PL spectra of WS_2/hBN is significantly different from those of WS_2 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 WS_2 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.

Acknowledgements

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References

[1] J. Shang et al., ***ACS Nano***, 9, 647 (2015).

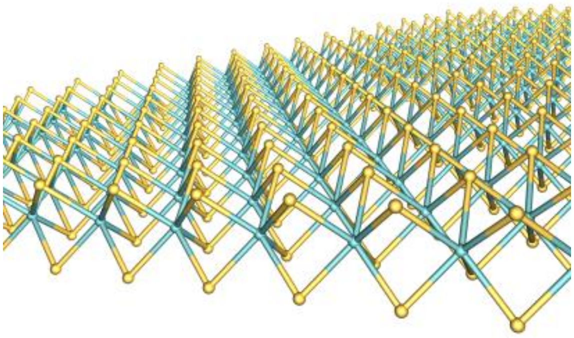

Fig.1 Model of TMDC. Yellow is chalcogen, and aqua is metal atom.

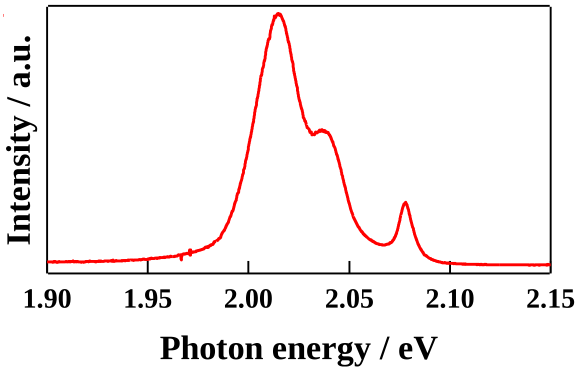

Fig. 2 PL spectra of WS_2 synthesized on hBN at 81.6 K. 3 features appeared.

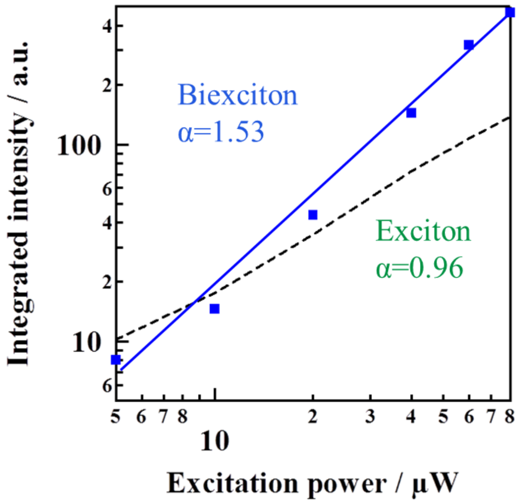

Fig.3 Excitation fluence of WS_2 synthesized on hBN. Black dotted line is exciton, gradient is 0.96. and blue line and dot is new feature. Its gradient is 1.53, suggests that this is biexciton state.