Investigation of Moiré Structures and Excitonic Behaviors in WS_2 Twisted Homobilayers

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Abstract

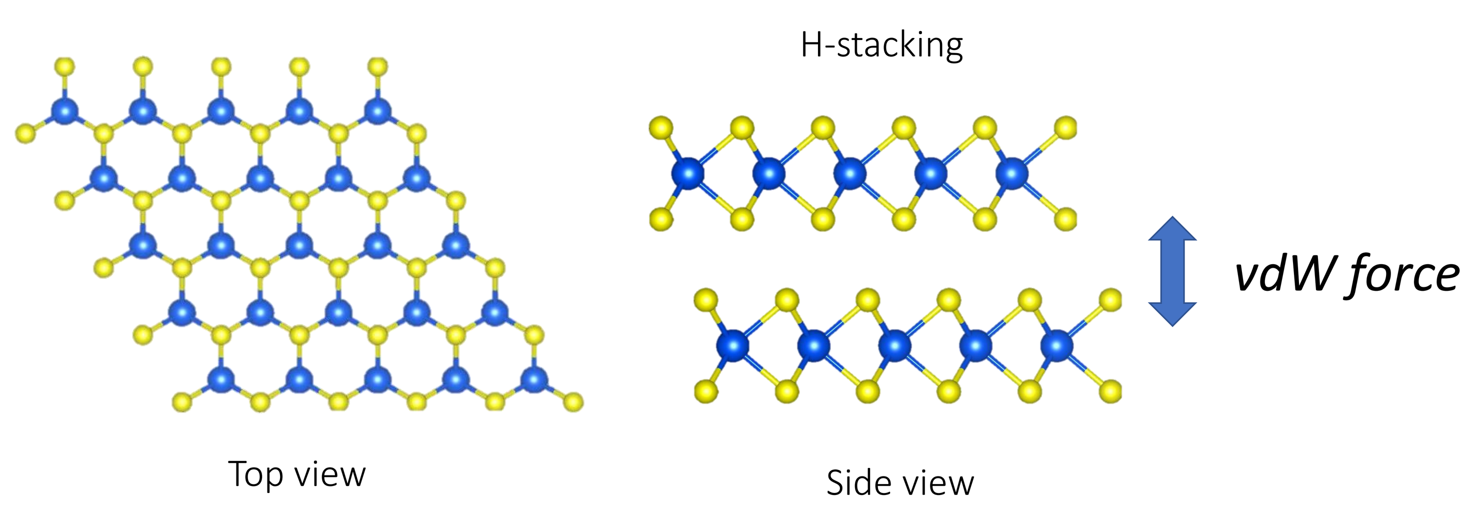
Moiré excitons in transition metal dichalcogenides have attracted considerable attention in recent years due to their unique electronic and optical properties. However, experimentally exploring the connection between moiré pattern and electronic structures remains challenging. In this study, we report the fabrication of WS_2 twisted homobilayers on hollow substrates, enabling the study of excitonic properties and microscopic moiré structures using transmission electron microscopy. Through photoluminescence and differential reflectance measurements, we detect a unique low-energy signal, which we attribute to moiré excitons. This versatile platform provides new opportunities to explore the interplay between moiré structure and excitonic behavior.

Key words : transitional metal dichalcogenides, van der Waals bilayer, moiré exciton

Transition Metal Dichalcogenides (TMDs)

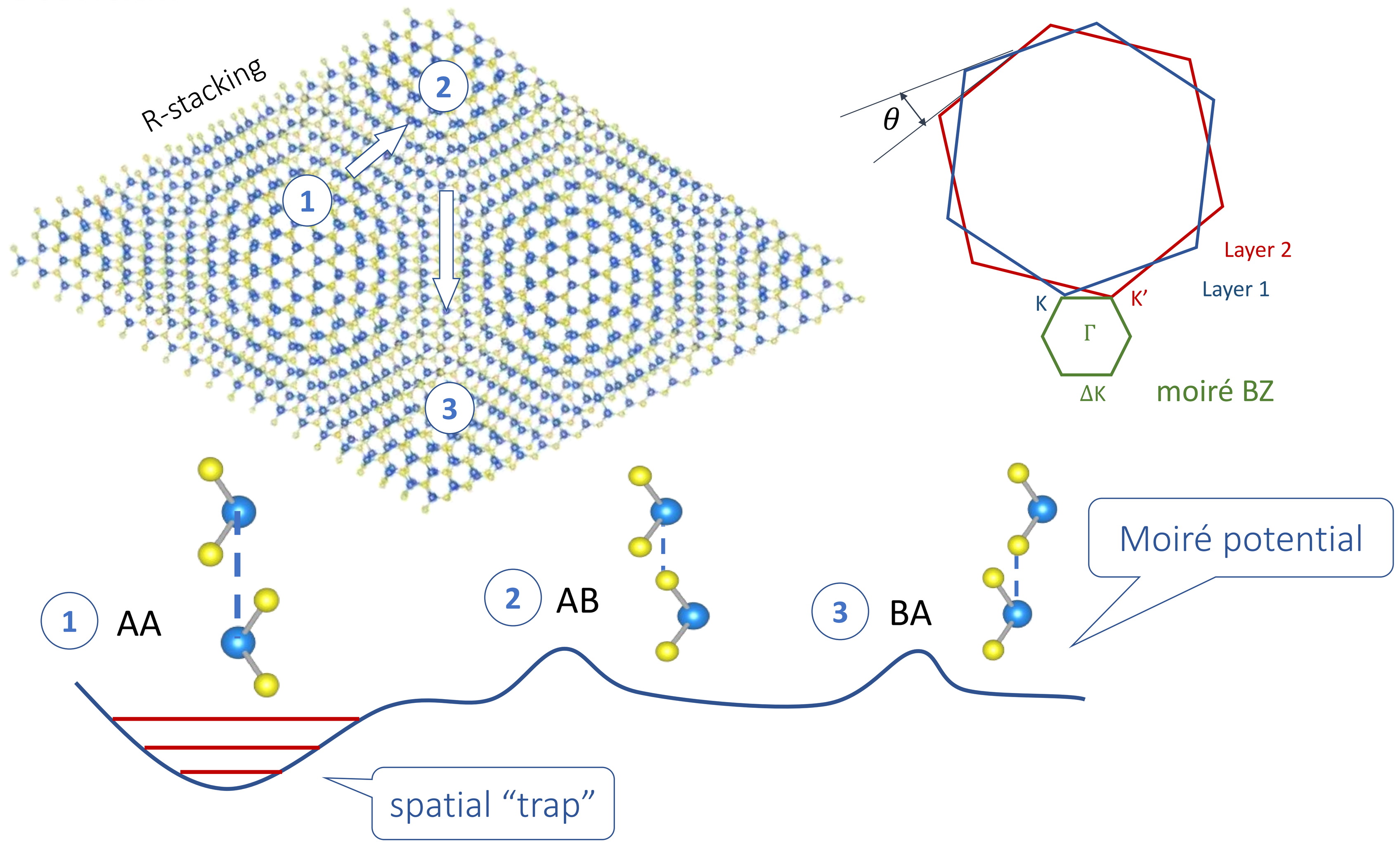
TMDs (MX_2) are semiconductor with layer and layer bonded by van der Waals force.

keywords : electron-electron coupling ; phonon dispersion ; exciton ; valleytronics ; spin-orbit coupling ; heterostructure.

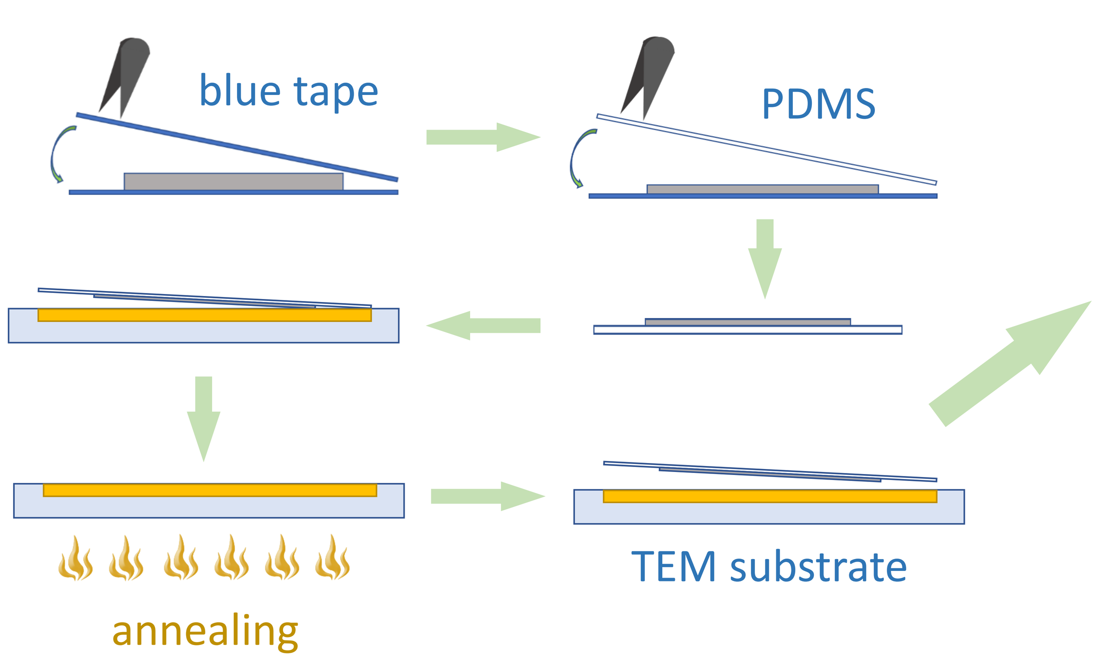


Moiré Structure

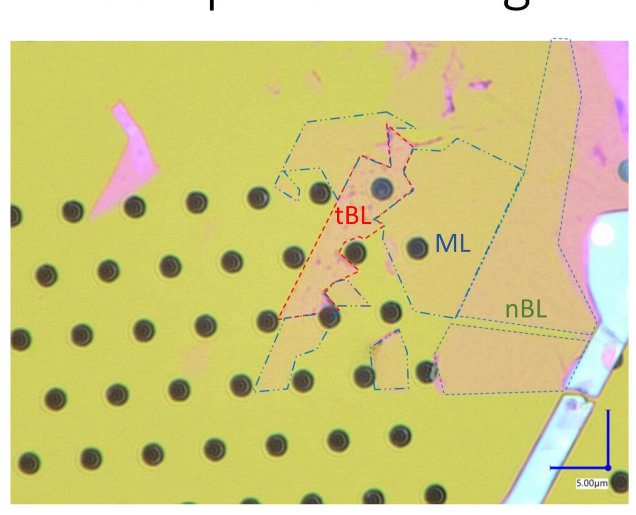
Either lattice constant difference or twisted angle between layer contribute to moiré Structure and therefore moiré potential.



Sample Fabrication and Probing Method

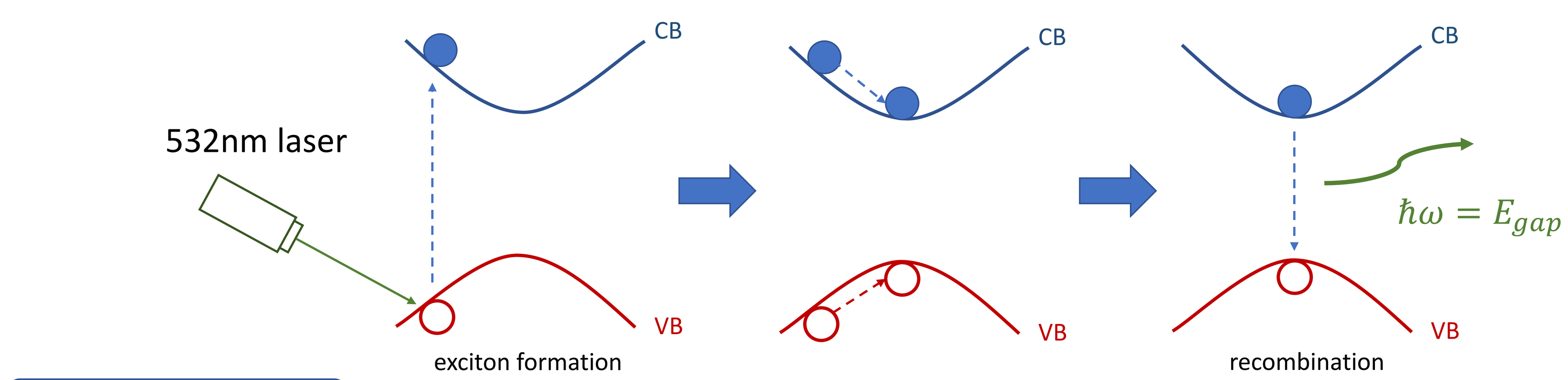


Sample OM Image



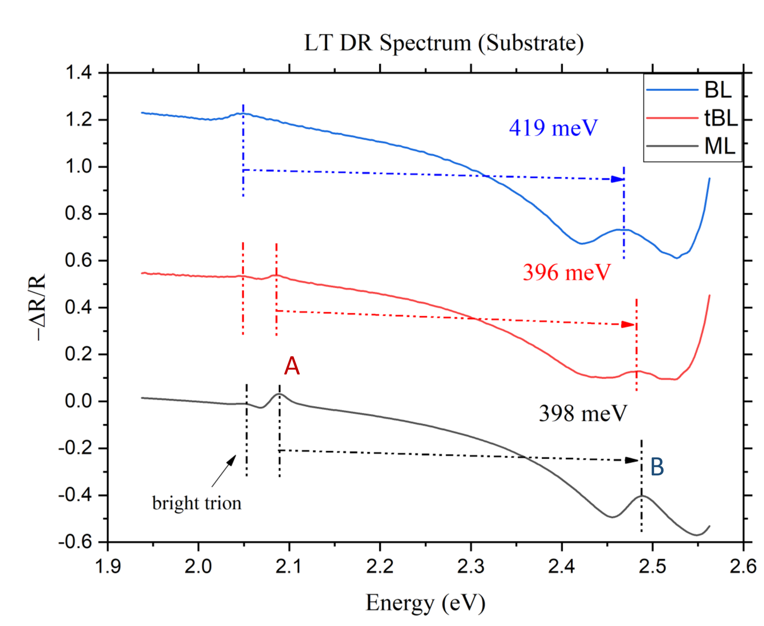
ML : monolayer
tBL : twisted bilayer
nBL : natural bilayer

- Photoluminescence Spectroscopy (PL)

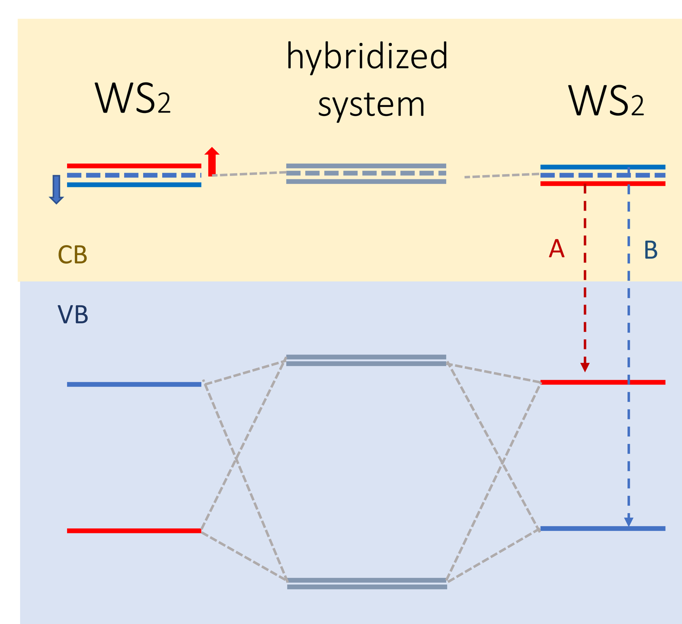


Result

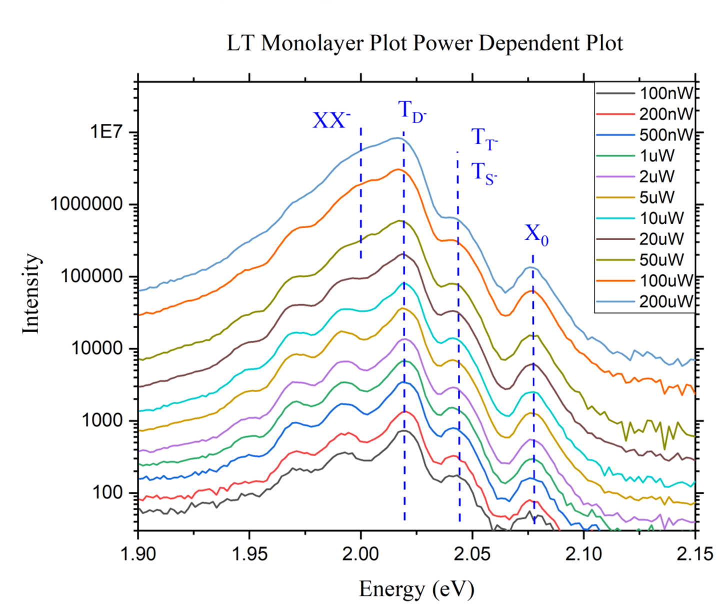
- DR Spectrum

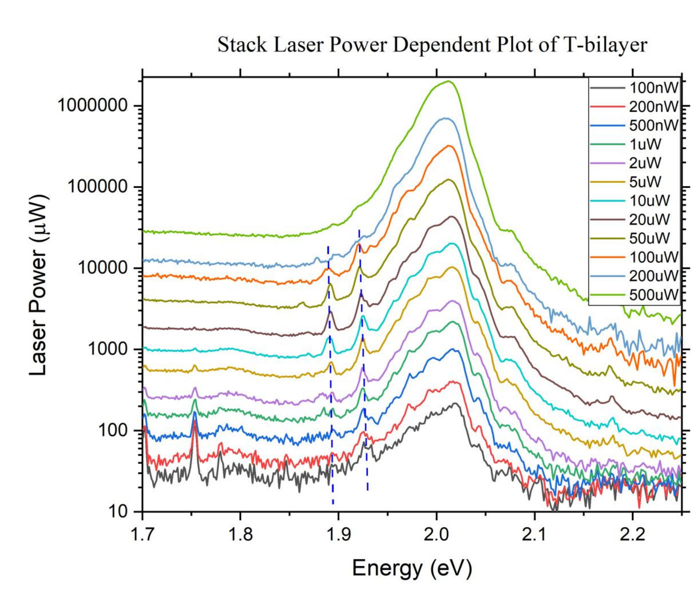


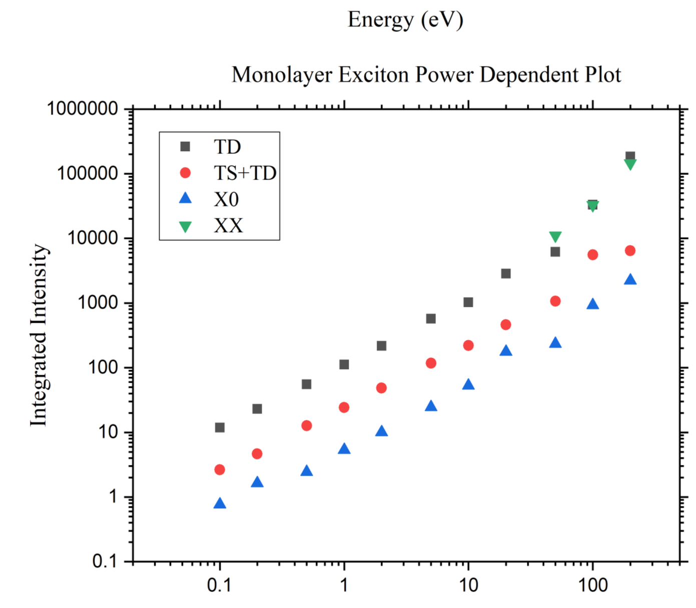
H-stacking

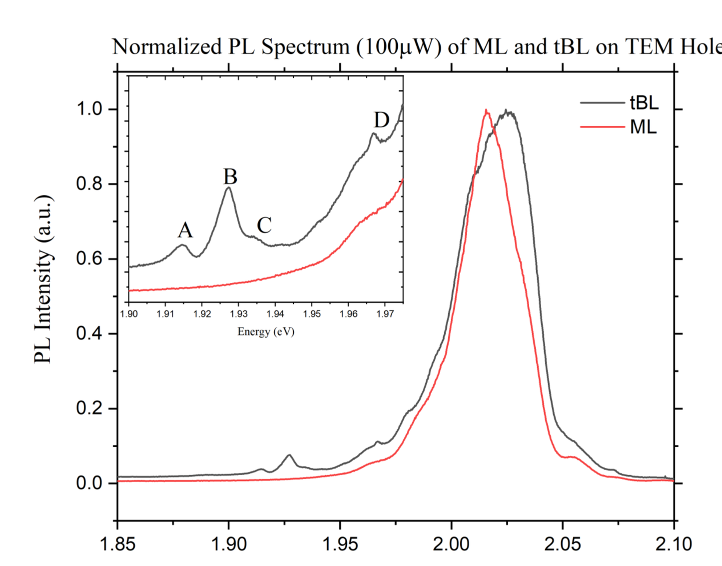


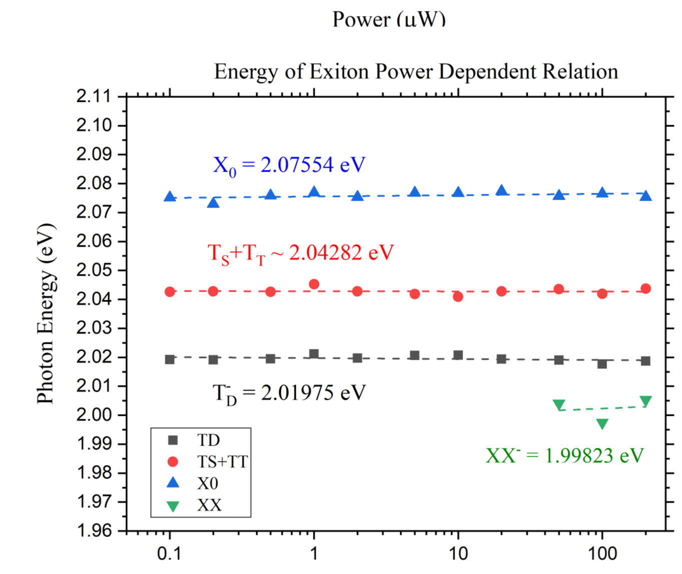
- PL Spectrum
  - Monolayer Regime (ML)
  - twisted Bilayer Regime (tBL)

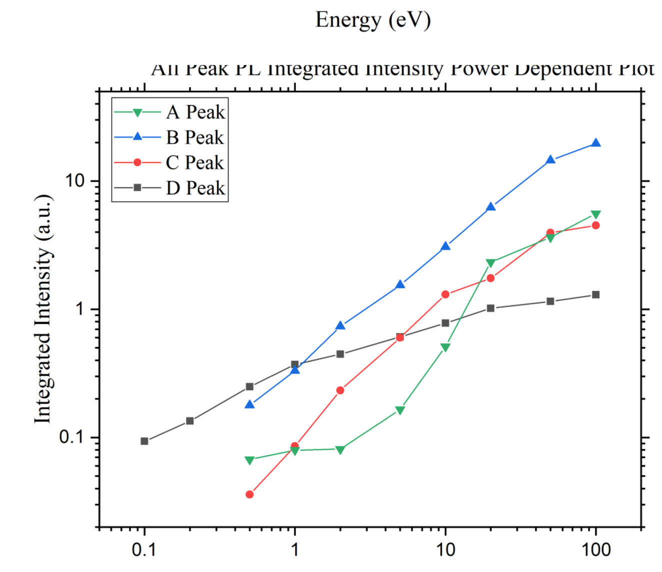












Conclusion and Further

Some small signals appear comparing to ML region, we conclude these to me moiré exciton via :

(1) Non-splitting of AB excitions (2) Non-linear growth of integrated intensity. (3) Saturation behavior with high electron doping.

Further steps includes Raman spectroscopy, phonon band mapping, and preforming TEM image for direct evidence and observation of moiré structure.

Acknowledgement

This research was supported by the National Science and Technology Council of Taiwan(Grant 112-2112-M-007-036-MY3) and the Yushan Fellow Program from the Ministry of Education of Taiwan (Grant MOE-109-YSFMS-0002-001-P1).