Metal-Organic Chemical Vapor Deposition of $PtSe_2$

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Platinum diselenide ($PtSe_2$), a novel two-dimensional material within the class of noble-metal dichalcogenides (NMDs), has recently received significant attention due to its outstanding properties. $PtSe_2$, which undergoes a semi-metal to semiconductor transition when thinned, offers a band gap in the infrared range and good air stability.[1] These properties make it a prime active material in optoelectronic and chemical sensing devices.[2] However, a synthesis method that can produce large-scale and reliable high-quality $PtSe_2$ is highly sought after.

Here, we present the growth of $PtSe_2$ by metal organic chemical vapor deposition (MOCVD). The technique allows high-quality growth on various centimetre-scale substrates characterized by Raman, X-ray photoelectron and X-ray diffraction spectroscopy, as well as scanning tunneling microscopy and spectroscopy. Domains within the films are found to be up to several hundred of nanometers in size, and atomic scale measurements show their highly ordered crystalline structure. The thickness of the continuous films, and thus their electronic properties can easily be varied via the growth time. This study provides fundamental guidance for the novel synthesis of high quality, large-scale $PtSe_2$ layers, hence offering a key requirement for the implementation of $PtSe_2$ in future electronic devices.[3]

References

[1] Ciarrocchi, A., Avsar, A., Ovchinnikov, D. & Kis, A., Nature comm. 9 (2018) 919
[2] Yim, C. et al., ACS nano (2016)
[3] Prechtl, M. et al., arXiv:2301.13709 (2023)

Figures

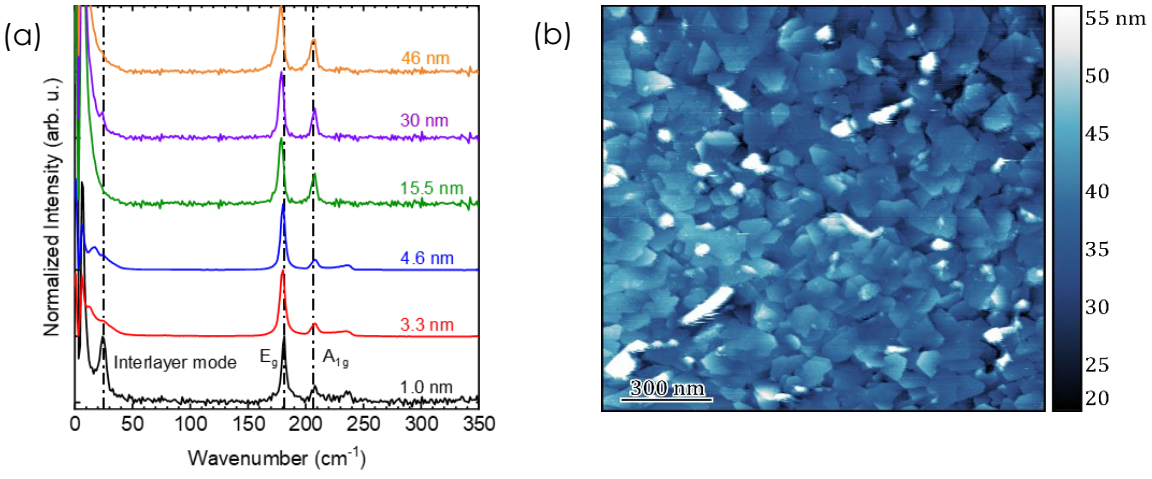

Figure 1: (a) Normalized, averaged Raman spectra of differently thick PtSe2 films grown on c-plane sapphire. (b) Large-scale STM image of PtSe2 grown on pyrolytic carbon.