Strain engineering of freestanding $PtSe_2$ films: Investigation of electrical and optoelectronic properties

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Platinum diselenide ($PtSe_2$) is a two-dimensional noble-metal dichalcogenide that has received significant attention due to its exceptional electronic properties and its versatility for optoelectronic and chemical sensing devices.[1] The material exhibits a transition from semi-metallic to semiconducting behaviour when thinned, opening an infrared bandgap.[2] Furthermore, the highly stable and robust $PtSe_2$ films exhibit strong piezoresistivity and show large thickness-dependent gauge factors making them a prime material for nano-electromechanical systems (NEMS).[3]

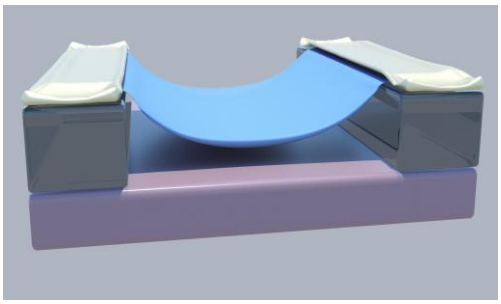
In this study, we produced freestanding 2D material films and investigated their electrical and optoelectronic response under controlled strain. Bridges of polycrystalline $PtSe_2$ were fabricated via thermally assisted conversion of pre-defined platinum channels directly on Si/SiO_2 target substrates.[1] After depositing electrical contacts, a trench was under-etched beneath the $PtSe_2$ to create a freestanding 2D material film. The electrical and optoelectronic properties of the film were studied at different strains, which can be controlled by applying a gate voltage. Thereby, we elucidate structural changes within the polycrystalline 2D material film and provide a device platform for multiple applications.

References

[1] Yim, C. et al., ACS nano (2016)
[2] Ciarrocchi, A. et al., Nature comm. 9 (2018) 919
[3] Wagner, S. et al., Nano Lett. 18 (2018) 3738

Figures

(a)



(b)

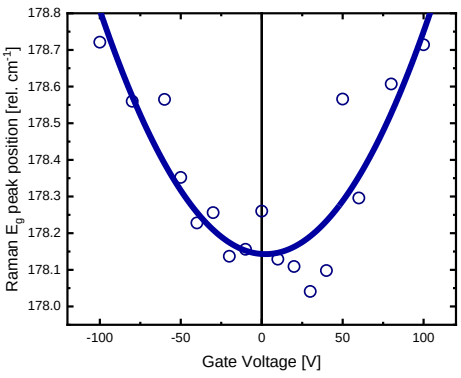


Figure 1: (a) Illustration of a freestanding $PtSe_2$ film under applied strain. (b) Shift of Raman peak position under various gate voltages.