Strain engineering in 2D transition metal dichalcogenides

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The study of 2D transition metal dichalcogenides (TMDs) under strain has attracted the interest of many researchers and will also pave the way for the flexible application of 2D materials. It is reported that strain has been applied to modify the optical properties of semiconductor TMDs.[1] Strain engineering has also been used to modulate the physical properties of TMDs.[2] The exciton dynamics of 2D TMDs has also been extensively studied.[3] However, researchers have less understanding of strain distribution and transport in strain engineering of 2D TMDs. How is strain transferred between layers of 2D TMDs and how efficiently is it transferred from the substrate? How is the stress distributed on the surface of 2D TMDs under strain? And most importantly: can we control the electronic and phononic properties of 2D materials with strain? Our project aims at answering these questions by studying phonon and exciton dynamics in chemical vapour deposition (CVD) grown, semiconducting TMDs with twisted angles on flexible and stretchable substrates. Non-destructive optical techniques such as high resolution Raman spectroscopy, photoluminescence (PL) and ultrafast pump-probe will be applied in order to fully understand the strain-enabled phonon-electron interactions. We have successfully synthesized high-quality monolayers of TMDs using CVD methods and transferred them to flexible PMDS substrates. Strain testing can be performed using a self-designed tensile platform matched to the Raman device. The PL spectra of the samples show a dependence on the strain level, which is in line with our expectations and similar to what has been reported in the literature. [4]

References

[1] Marianna Sledzinska et al, Appl. Phys. Lett., 121-25 (2022) 253101.
[2] Yalan Yan et al, RSC Adv., 10 (2020) 39455-39467.
[3] Navendu Mondal et al, 34 (2022) 2110568.
[4] Fang Wang et al, 2D Mater., 7 (2020) 045022.

Figures

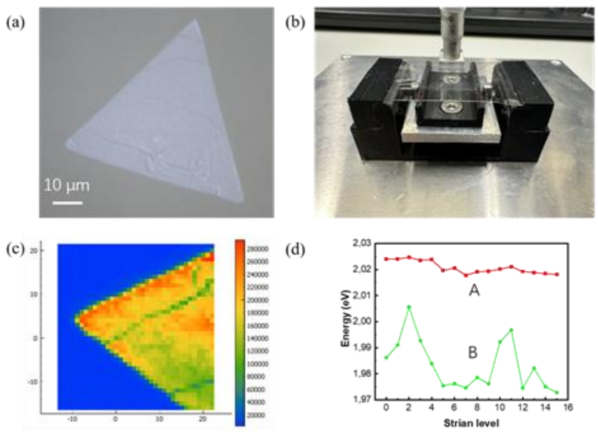

Figure 1: a) Optical microscopy image of MoS_2 transferred onto PDMS. (b) Image of a self-designed tensile strain platform. (c) PL mapping spectra of MoS_2 on PDMS. (d) Strain dependence of PL peaks of WS_2.