Manipulation of Transition Metal Dichalcogenides: AFM Nanomachining of 2D $PtSe_2$

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Abstract

2D layered materials such as transition metal dichalcogenides (TMDs), have been heavily studied due to their high potential for use in a wide range of future nanoelectronic devices.[1] Some semiconducting TMDs, such as MoS_2, are known to change their bandgap with decreasing layer thickness. Other TMDs, such as $PtSe_2$, have been shown to develop a band gap, i.e. go from semimetallic to semiconducting.[2]

By using novel manipulative techniques such as nanomachining with an atomic force microscopy (AFM), TMDs can be incrementally machined down and their electrical properties monitored. The change in surface potential can be characterised by Kelvin probe force microscopy (KPFM). Further nanomachining of contacted TMD channels can be performed while monitoring the device performance with each layer removal down to the monolayer. This would enable the design of `self-contacted' devices based on TMDs through the creation of a semiconducting channel via nanomachining with high mobility, low contact resistance and low power.[3]

References

[1] P. Miró, M. Audiffred, T. Heine, Chem. Soc. Rev., 43, 6537 (2014)
[2] Y. Wang et al., Nano Lett., 15 (6), 4013, (2015)
[3] M. Ghorbani-Asl et al., Adv. Mater., 28, 853 (2016)

Figures

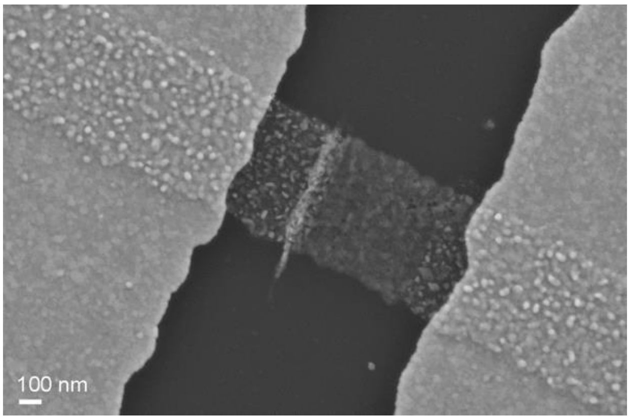

Figure 1: SEM of nanomachined thermal-assisted conversion (TAC) films of $PtSe_2$

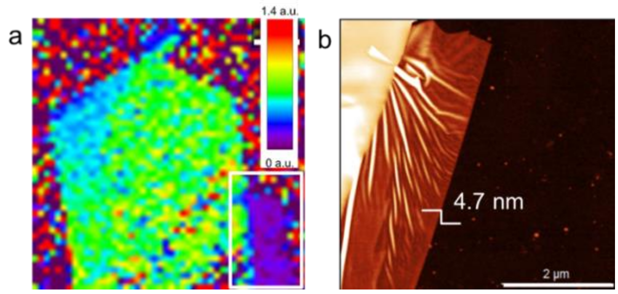

Figure 2: (a) Raman map of multilayer mechanically exfoliated $PtSe_2$ with bilayer region indicated by box
(b) Topographical AFM of bilayer region of $PtSe_2$