Defect engineering and functionalization of 2D Transition Metal Dichalcogenides for Electrocatalysis and Molecular Sieving

Damien Voiry[1]

[1] Institut Européen des Membranes (IEM, CNRS UMR5635, UM, ENSCM), Montpellier, FRANCE

damien.voiry@umontpellier.fr

Among the family of 2D materials, transition metal dichalcogenides (TMDs) are intensively investigated for opto-electronic and electro-catalytic applications[1,2]. The properties of TMDs can be largely tuned by changing their elemental composition, their thickness and their atomic structure[1]. Besides phase engineering, the properties of 2D materials can be tuned by changing the defect concentration such as sulfur vacancies. In addition we have recently demonstrated that TMD nanosheets can be covalently functionalized which opens new avenues for controlling the surface chemistry and the opto-electronic properties of exfoliated TMDs[3]. Nanolaminate membranes made of two-dimensional materials (2D) such as graphene oxide (GO) are also promising candidates for molecular sieving via size-limited diffusion in the 2D capillaries[4]. Controlling the surface chemistry of the 2D nanosheets can provide additional tools for enhancing the sieving performance of the nanolaminate membranes (Figure 1). Through several examples, I will present our recent strategies for engineering exfoliated nanosheets of TMDs. My presentation will highlight how these strategies can be used for fine tuning the properties of the 2D TMDs and other 2D materials for electrocatalysis and molecular sieving.

References

[1] Wang, Q. H., Kalantar-Zadeh, K., Kis, A., Coleman, J. N. & Strano, M. S. Electronics and optoelectronics of two-dimensional transition metal dichalcogenides. Nat. Nanotechnol. 7, 699–712 (2012).

[2] Voiry, D., Yang, J. & Chhowalla, M. Recent Strategies for Improving the Catalytic Activity of 2D TMD Nanosheets Toward the Hydrogen Evolution Reaction. Adv. Mater. n/a-n/a (2016). doi:10.1002/adma.201505597

[3] Voiry, D., Mohite, A. & Chhowalla, M. Phase engineering of transition metal dichalcogenides. Chem. Soc. Rev. 44, 2702–2712 (2015).

[4] Joshi, R. K. et al. Precise and Ultrafast Molecular Sieving Through Graphene Oxide Membranes. Science 343, 752–754 (2014).

Figures

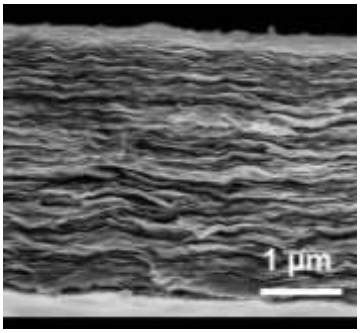

Figure 1. SEM images of a nanolaminate membrane made of exfoliated TMD nanosheets