H_2-bulged membranes made of transition metal dichalcogenides: an AFM study

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The combination of extremely high stiffness and bending flexibility with tunable electrical and optical properties makes van der Waals transition metal dichalcogenides (TMD) appealing both for fundamental science and applied research.

Here, we exploit the hydrogen storage capability of micrometric and sub-micrometric H_2-bulged membranes (nano-blisters) by employing nano-scale experiments based on atomic force microscopy (AFM) techniques. Those blisters have been produced by performing low-energy proton bombardment of TMD bulk flakes and their size and position have been controlled by engineering the flake surface prior to the bombardment procedure.

We carried on a complete characterization of the bulged TMD membranes, both from mechano-elastic and thermodynamic point of views, by quantifying stretching modulus and stress/strain of the membrane, as well as hydrostatic pressure and mole number of the trapped H_2 gas [1,2].

Moreover, the effect of the H_2-bulging, and the consequently induced strain of the membrane, on the electronic properties of the TMD is under investigation.

We believe that the outcome of this work will find valuable applications, ranging from nanodevice manufacturing, opto-electronic tunable devices, straintronics, and, last but not least, clean energy technologies. Indeed, the studied nano-blisters combine the superlative mechano-elastic properties of 2D materials with the capability of store gases, such as hydrogen, at ambient pressure and temperature.

[1] C. Di Giorgio, et al. *Nano-scale measure of elastic properties and hydrostatic pressure in H2-bulged MoS2 membranes*, Adv. Mater. Interfaces 2020, 2001024

[2] E. Blundo, C. Di Giorgio, et al. *Engineered creation of periodic giant, non-uniform strains in MoS2 monolayers*, Adv. Mater. Interfaces 2020, 7, 2000621