Strong nanomechanical softening signature induced by memristive charge accumulation in suspended monolayer MoS_2

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Abstract

The new 2D transitions metal dichalcogenide (TMDs) as MoS_2 represents ideal material for multiple purposes. MoS_2 is promising for electronic transistor and fundamentals phenomena such as superconductivity or valleytronic. It is a rich platform for optoelectronic; excitonic effects have high binding energy, strain engineering can induce a high tunability of the band gap itself. Moreover, MoS_2 transit between different crystalline phase (2H-1T) making this material interesting for memristive devices and energy storage.

Nanomechanical systems have been at the heart of recent physic discoveries of importance, from the detection of cosmic gravitational waves to the sensitivity record for detection of mass or force. It is a recent and almost universal probe of condensed matters issues and quantum mechanics. Since 2007, the emergence of suspended atomically thin materials, with the largest geometrical aspect ratio which can be obtained, brought new insight in nanomechanical resonators with very low mass and spring constant, high elongation resistance, high frequency-tuning and especially strong mechanical non-linearities. A high potential release in MoS_2 for nanomechanics. It opens new experimental perspectives by measuring unique intrinsic properties when transduced into the mechanical motion. We propose to focus on unexpected electrical behaviors measured in our samples[1,2]: a strong photodoping under illumination and a hysteretic loop in the I-V curve corresponding to a memristive effect. We use the sensitivity of our mechanical MoS_2 membrane as a non-conventional probe to explore deeply these intriguing behaviors and we have seen a strong effect of softening due to the non-linear charge of the devices.

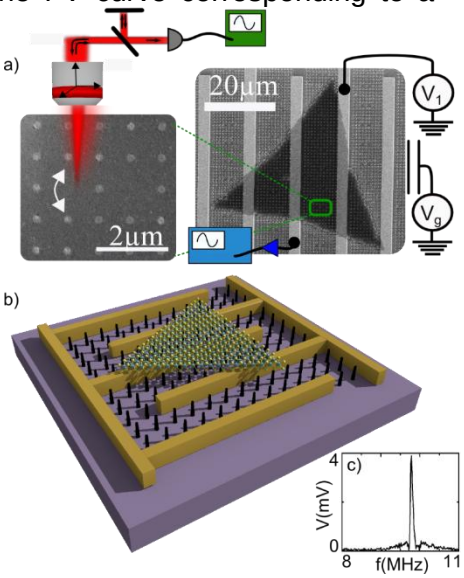

Figure 1 We explore these topics within unique sample geometry of a suspended single layer membrane of the MoS_2 embedded in a nano-opto-electro-mechanical system (NOEMS)

1. Chaste, J. *et al.* Intrinsic Properties of Suspended MoS2 on SiO2/Si Pillar Arrays for Nanomechanics and Optics. *ACS Nano* (2018). doi:10.1021/acsnano.7b07689
2. Chaste, J. *et al.* Nanostructures in suspended mono- and bilayer epitaxial graphene. *Carbon* **125,** 162–167 (2017).