Phase transition in a memristive suspended monolayer MoS2 probe measured by nano-opto-electro-mechanics

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The capacity of semiconducting single-atomic-layer to concatenate multiple interesting properties into a single component represents an opportunity to create new devices at the interface between several domains. Here, combining opto-mechanical and electronical measurement, we demonstrate the presence of transition 2H - 1T' in suspended 2D membranes of MoS2. The electronic transport of our sample showed rather unexpected memristive properties without external dopants as lithium. The memristive effect is related to two distinct notions: the polymorphism of TMD with crystalline phase transition from 2H-MoS2 to the topological phase 1T', as well as the diffusion of sulfur vacancies (SV) along with the material. We monitor the variation of the mechanical vibration during measurements of the memristive effect in order to detect the 3% directional elongation of this phase 1T' with respect to the phase 2H. We reveal the signature of crystalline transition 2H - 1T' for a very small part of the material with a very strong softening of the membrane First-principles total energy calculations reveal the underlying mechanism for the SV migration. We have confirmed experimentally and theoretically that a high density of Sulfur vacancies creates a few percent of 1T' phase in our sample which is modulated during the memristive measurements. Our results show that nanomechanics have an unprecedented sensitivity to phase transition.

Figures

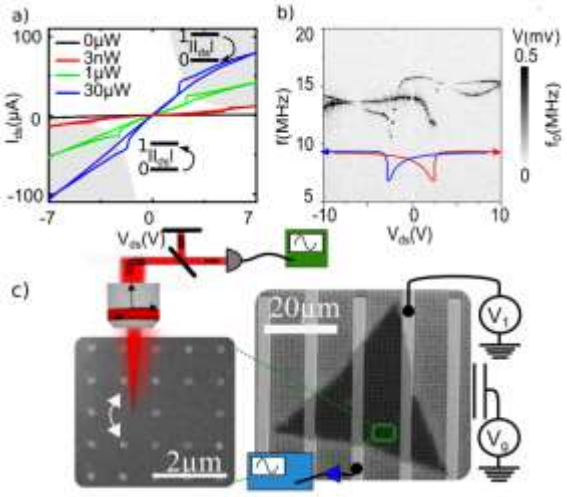

Figure 1 : Unexpected memristive effect obtained on the IV curve of a suspended monolayer MoS2 and b) optomechanical measurement of the same behavior trough the vibration frequency c) image of the set-up and device