New method for ex-situ 2D-memristor characterization for memristive mechanism exploration

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2D memristors based on transition metal dichalchogenides are promising devices for non-volatile memory, radio frequency (RF) switches and multi-level memristor. Such devices are made of a 2D film sandwiched between two metal electrodes. They switch, in a reversible way, from a non-conductive (OFF) to a conductive (ON) state [1]. Physical phenomenon enabling the switching is currently under discussion basis on both simulation works [2] and experimental observations [3]. However, a reliable characterization of the active layer is difficult because the 2D films found under the top electrode in the device configuration/structure. In this work, we developed a way to mechanically remove the top electrode leaving the 2D film on the bottom electrode. A nickel spalling process shown in Figure 1(A) allowed a direct access to the 2D active layer. After the exfoliation of the top electrode, we studied a device both in ON state and in initial state using KPFM measurement. (No electrical switching before the top electrode exfoliation). For the ON state device, we can clearly observe a hot spot at an electrons doped area (Figure 1(B)). On the contrary, for the initial state device, the surface potential above the bottom electrode is quite homogeneous and the presence of hot spot is not observed. This phenomenon has been recognized and confirmed in several devices. The presence of a hot spot in ON state and its absence for the in initial state, make us conclude that this hot spot correspond to the conductive path created by the commutation. These observations corroborate the idea of a conductive filament creation in the 2D material. To conclude, this work enabled to find a new access to the active layer in 2D memristors and open the field of possibilities for the memristive phenomenon characterization in 2D-memristors.

References

[1] J. B. Roldán *et al. Advanced Intelligent Systems*, vol. 5, nº 6, (2023) p. 2200338, 2023.
[2] G. Boschetto, S. Carapezzi, et A. Todri-Sanial, *Nanoscale Advances*, vol. 5, nº 16 (2023) p. 4203-4212.
[3] B. Tang *et al.*, *Nat Commun*, vol. 13, nº 1 (2022) p. 3037

Figures

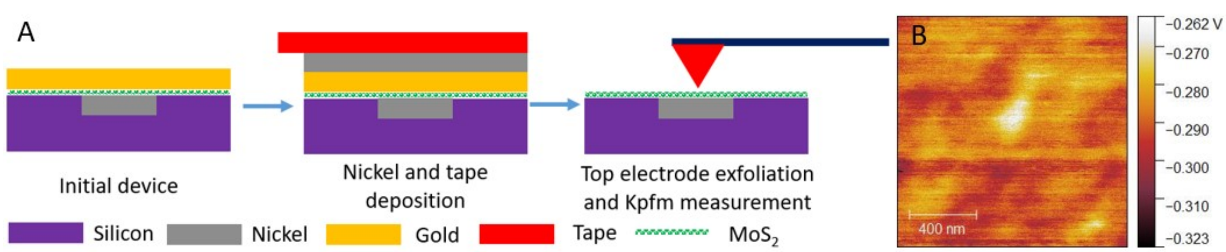

Figure 1: (A) Process used for KPFM characterization (B) KPFM measurement image of the ON state device