# Metal – insulator transition in free-standing $VO_2/TiO_2$ microstructures through low-power Joule heating

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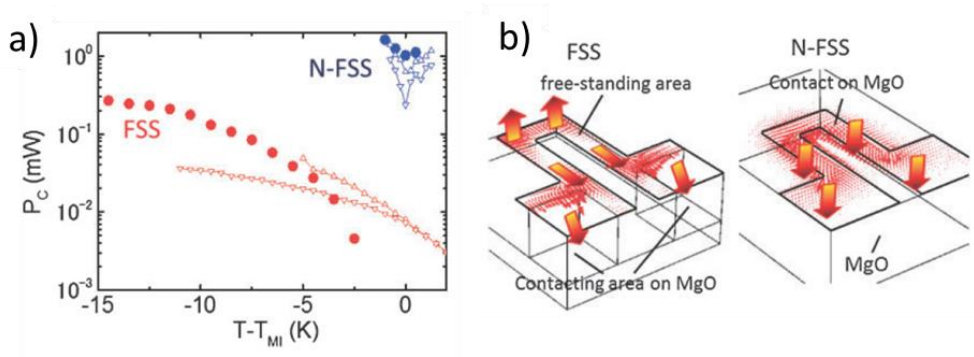
Vanadium Dioxide ($VO_2$) shows a large decrease of electrical resistance of several orders of magnitude at around 340 K with the formation of a mixed phase containing insulating and metallic domains that can be controlled by external *stimuli* such as electrical biases [1] or temperature. We reported multi-resistive $VO_2$-based microdevices by fabricating free-standing (FSS) $VO_2/TiO_2$ microstructures [2] that can be easily heated by Joule effect. In this work, we investigate the thermal behavior of FSS and non-freestanding (N-FSS) $VO_2$-based structures. The electrical resistance of the devices shows an abrupt jump with increasing the voltage bias across their two input terminals. We analyze and compare the electrical power needed to drive the devices from the (low temperature) insulating to the (high temperature) metallic state. Our results indicate how the power needed to drive the FSS is two orders of magnitude lower that that required for the N-FSS and how thermal flow design of the microstructures is a critical issue for developing optimized switching and memristive devices.




a) Dependence of the electrical power Pc at the insulator to metal transition driven by the voltage bias at different temperatures T ($T_{MI}$ is the metal insulator transition temperature). Solid symbols are experimental data, while open ones show calculated data by Finite Element Analysis. b) Thermal flow of FSS and N-FSS structures calculated by Finite Element Analysis showing how in the FSS heat flows mainly along the structures toward the contacts to the substrate (MgO).

[1] T. Kanki, K. Kawatani, H. Takami, and H. Tanaka, Appl. Phys. Lett. 101 , 243118 (2012).

[2] L. Pellegrino, N. Manca, T. Kanki, H. Tanaka, M. Biasotti, E. Bellingeri, A. S. Siri, and D. Marré, Adv. Mater. 24 , 2929 (2012).