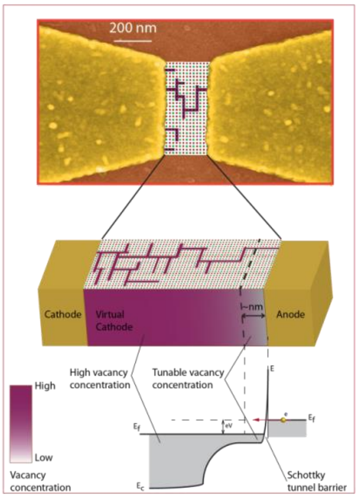
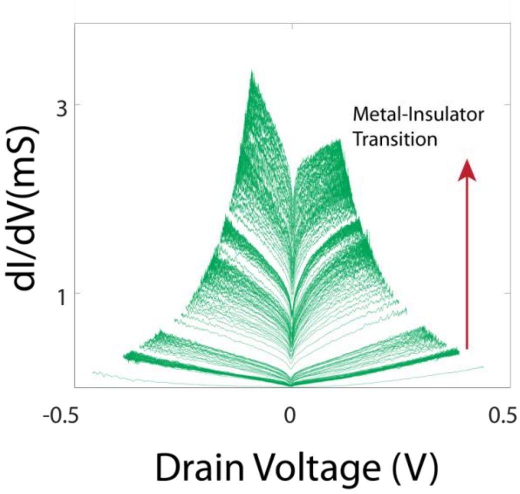
Metal Oxide Resistive Switching: Evolution of the Density of States across the Metal-Insulator Transition





The migration of oxygen vacancies by an electric field has been employed recently for the fabrication of memristive devices, devices that could possibly become essential in future Von Neumann or neuromorphic computing architectures. In these devices, the oxygen vacancies play the role of doping sites.

In this work published in PRL[1], we report the study of gold-SrTiO3 (STO)-gold memristors where the doping concentration in STO can be fine-tuned through electric field migration of oxygen vacancies. In this tunnel junction device, the evolution of the density of states (DOS) can be followed continuously across the metal-insulator transition (MIT). At very low dopant concentration, the junction displays characteristic signatures of discrete dopant levels. As the dopant concentration increases, the semiconductor band gap fills in but a soft Coulomb gap remains. At even higher doping, a transition to a metallic state occurs where the DOS at the Fermi level becomes finite and Altshuler-Aronov corrections to the DOS are observed. At the critical point of the MIT, the DOS scales linearly with energy $N(\epsilon)\sim\epsilon$, the possible signature of multifractality for electronic wave functions.

This observation allowed confirming recent theoretical predictions[2] on the metal-insulator transition. This transition is a complex quantum percolation phenomenon whose theoretical description is not completed yet.

1. Mottaghizadeh, A., Yu, Q., Lang, P. L., Zimmers, A., & Aubin, H. Metal Oxide Resistive Switching: Evolution of the Density of States Across the Metal-Insulator Transition. Physical Review Letters (2014) 112(6), 066803.
2. I. S. Burmistrov, I. V. Gornyi, and a. D. Mirlin, Phys. Rev. Lett. **111**, 066601 (2013).

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