Mott memory and artificial neuron based on Mott insulators

Applications of the insulator-to-metal transition electrically induced in Mott Insulators

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The application of short electrical pulses on narrow gap Mott insulators induces a new phenomenon of resistive switching (RS). This insulator-to-metal transition (IMT) is volatile above threshold electric fields of a few kV/cm and becomes non-volatile and reversible (RS) for higher electric fields. This phenomenon is driven by the electric field, which triggers an electronic avalanche through injection of hot carriers. It induces the breakdown of the Mott insulating state at the nanoscale and creates the formation of granular conductive filaments. Such properties have been demonstrated in several Mott insulators, including oxides (V_2O_3:Cr) and chalcogenides ($NiS_{2-x}Se_x$ or AM_4Q_8 family (A=Ga, Ge; M=V, Nb, Ta, Mo; Q=S, Se)).

Both volatile and non-volatile transitions can occur at room temperature and are therefore suitable for applications. The non-volatile transition can be used for memory and memristor applications. Indeed, the $(V_{1-x}Cr_x)_2O_3$ based devices realized by magnetron sputtering exhibit very competitive memory performances. Moreover, the volatile transition allows to implement the Leaky-Integrate-and-Fire (LIF) functionalities of an artificial neuron. Our results stand as basis for a new electronics based on the Electric Mott transition: Mottronics.

After a review of published results on Mott Insulators, our latest developments will be presented and discussed.