Nonpolar resistance switching of a metal/binary transition metal oxides/metal sandwich: homogeneous/inhomogeneous transition of current distribution.

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Exotic features of a metal/insulator/metal sandwich is brought to light from a physical point of view; here the insulator is one of the strongly correlated binary transition-metal oxides (TMO) such as Fe_2O_3, CoO, NiO and CuO. The sandwich exhibits an unusual **resistance switching** reversibly between two states: one is a highly resistive off-state and the other is a conductive on-state.

Resistance switching phenomena of metal/conventional-oxide/metal sandwiches have been studied for half a century, but our samples show clear difference from the well-known examples, especially at the following three points. 1) **Current–voltage (I–V) duality**: precipitous change of resistance with large hysteresis appears both in d.c.-voltage and d.c.-current sweep measurements equally. 2) **Non-volatile threshold switching**: although it looks like the typical threshold switching due to the spatio-temporal pattern formation, neither S-type nor N-type negative differential conductance is seen in the I–V curve. Moreover, the switching is absolutely non-volatile. 3) **Nonpolar switching**: both of the switchings from on- to off-state ("reset") and from off- to on-state ("set") can be done without changing the polarity (unipolar switching), while they can be equally done by alternating polarity (bipolar switching); thus, it seems the switching does not depend on the polarity of the applied current or voltage.

These novel features are challenges for phenomenological and microscopic models of resistance switchings, and could be the basis for a drastically innovative nonvolatile memory device.

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