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Revealing the Nature of Nano-filaments in Memristive Oxide Memories

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Extended Abstract

Memristive switching in oxide semiconductors relies on the formation and disruption of conductive nano-filaments [1]. This effect is considered promising for the next generation of non-volatile memories. Yet, the switching event is a complicated electronic and ionic process, which may involve more than one mechanism. In order to elucidate the switching mechanism, advanced microscopy investigations proved challenging because of heavily dependence of the results on specimen preparation techniques. Important information can be obtained if switching leads to a macroscopic change of non-electrical properties, for instance magnetic properties. In this respect, n-type Mn-ZnO and p-type NiO provide a unique test-beds since the magnetic properties of these oxides are strongly dependent on the distribution of oxygen vacancies [2].

We show that resistive switching in n-type ferromagnetic Mn-ZnO and p-type antiferromagnetic NiO coexists with a switching of the magnetic phase. Thin films of these oxides were sandwiched between two metallic electrodes and resistive switching was induced. Nano-devices were patterned out of the trilayers by resorting to electron beam lithography and physical etching. We found that a switching of the resistance corresponds to a switching of the magnetic phase in the film [3, 4]. By measuring the magnetic properties of the devices in the two resistive states, we can draw important conclusions on the underlying switching mechanism. For instance, in Mn-ZnO the effect is not filamentary type and occurs uniformly under the interface, whereas in NiO the effect is filamentary type. By measuring the change of magnetic properties we could exclude that switching was due to the formation of Ni-ion filaments across the device. We have demonstrated [4] that the switching is due to the formation and rapture of oxygen-vacancy filaments.

References

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