

Development of an AFM-based technique for extended write/erase endurance measurements of memristive cells

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Abstract:

Memristors are devices composed of materials whose electrical resistivity can be modified by application of adequate bias voltages. The resistance state of {electrode/film/electrode} memristive cells may thus be reversibly switched between at least two regimes: a high-resistance state R_{High} and a low resistance state R_{Low} . Switching repeatedly between R_{High} and R_{Low} allows to obtain the maximum number of “write/erase” cycles before failure. Such parameter (denoted endurance) is interesting to examine [1,2] towards potential applicabilities to non volatile memories or bio-inspired neuromorphic circuits.

Usually, wires and/or macroscopic probes are used to apply a bias between the electrodes of the studied cell, provided the electrodes are large enough ($\geq 100 \times 100 \mu\text{m}^2$). If these electrodes are too small or fragile, they need to be electrically connected to intermediate remote larger areas which are wired to the measurement unit.

Here, we report a simple endurance measurement technique based on Atomic Force Microscopy (AFM): a small AFM conducting probe (tip radius $< 30\text{nm}$) touches directly the top electrode of the cell. In this configuration, application of pulses and measurements of resistance states can now be carried out in a completely automated way, either in ambient air, or under lower relative humidity ($\text{RH} \leq 2\%$). Such a technique has been applied to {Au/ Li_xCoO_2 /doped Si} memristive cells (Figure 1).

Keywords: resistive switching, Atomic Force Microscopy (AFM), non volatile resistive memories (ReRAM), write/erase cycles, endurance.

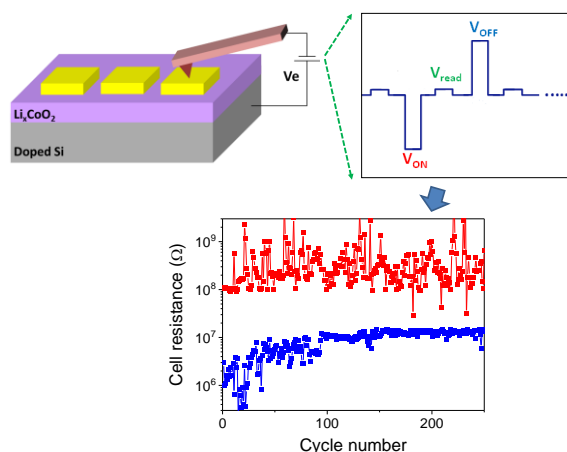


Figure 1: Top-Left: schematic view of the setup. Top-Right: shape of the voltage pulses applied. Bottom: evolution of R_{High} (red) and R_{Low} (blue) of a $100 \times 100 \mu\text{m}^2$ {Au/ Li_xCoO_2 /doped Si} cell, under dry air ($\text{RH} \leq 2\%$, read voltage: 0.1V).

References:

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2. V.S. Nguyen et al (2018), Direct Evidence of Lithium Ion Migration in Resistive Switching of Lithium Cobalt Oxide Nanobatteries, *Small*, 14, 1801038