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# UNIMORE RRAM MODEL V1.0.0 SPECTRE SIMULATION RESULTS

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## Benchmark experiments

Netlist: IV\_characteristic.scs

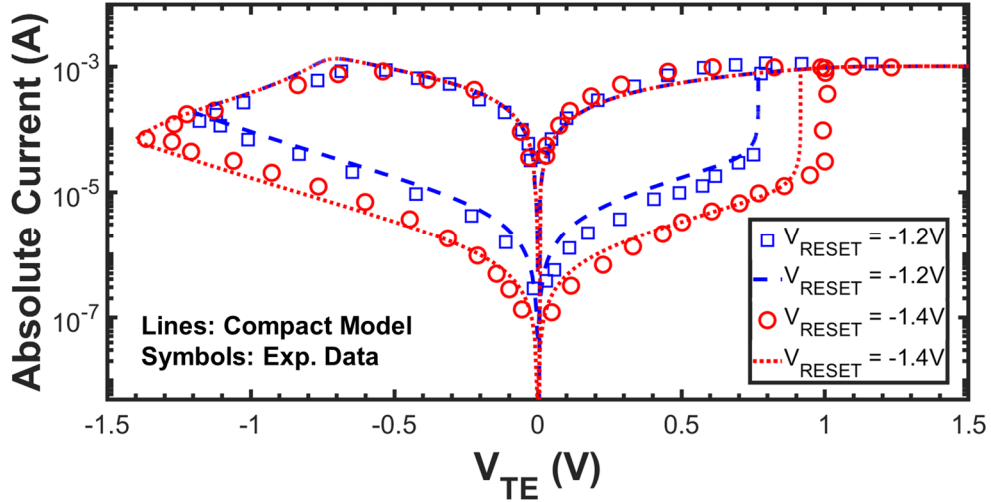


Fig. 1 - Simulated (lines) and experimental (symbols) device I-V curves at different  $V_{RESET}$ . Data from [1]. To perform the simulation at different  $V_{RESET}$ , the simulation parameter vreset needs be changed accordingly.

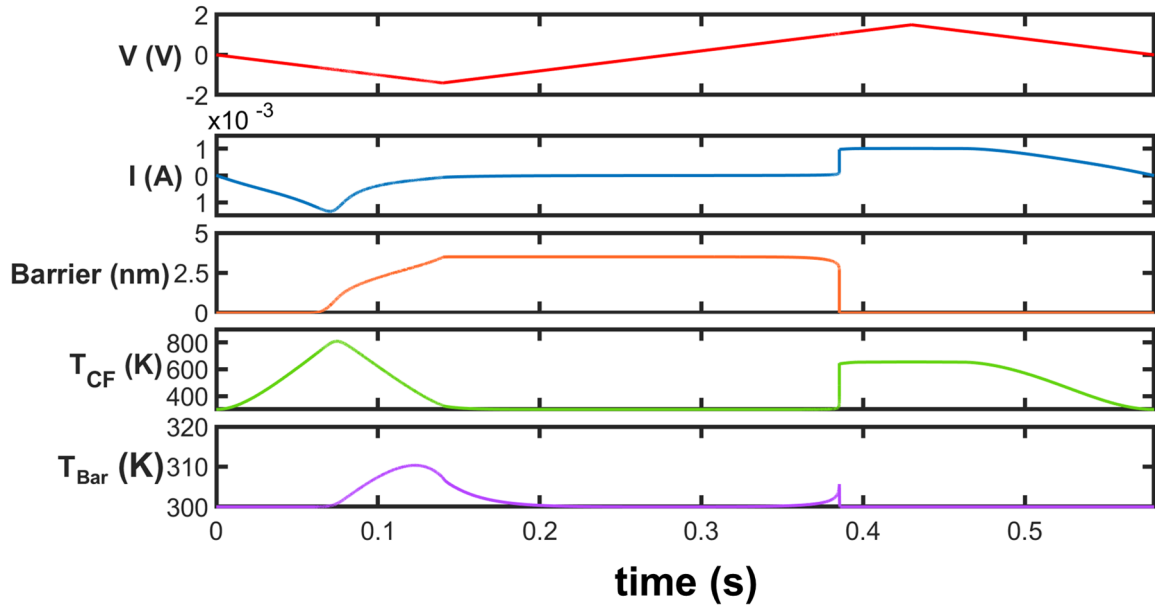


Fig. 2 - Model variables time evolution during the simulation in Fig.1. The first plot shows the applied triangular waveform, which causes a RESET event followed by a SET event.

Netlist: Pulsed\_RESET\_test.scs

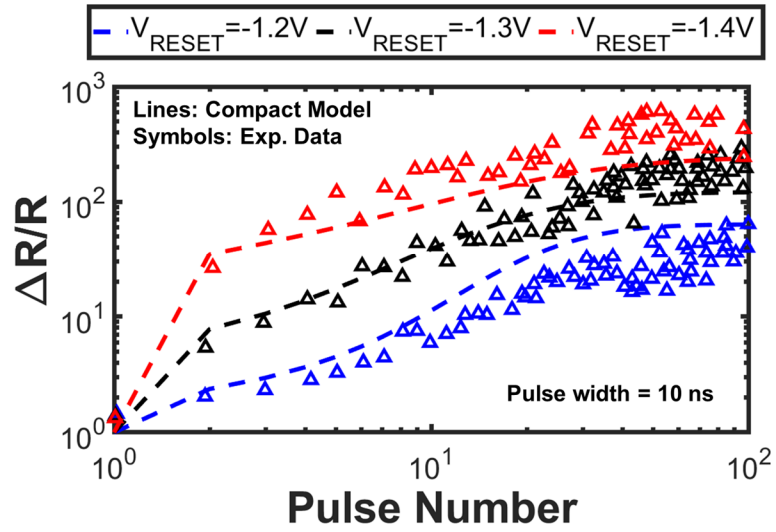


Fig. 3 - Simulated (lines) and experimental (symbols) pulsed reset curves using a train of 10 ns pulses with different amplitude. Data from [1].

Netlist: IV\_characteristic\_wVariability.scs

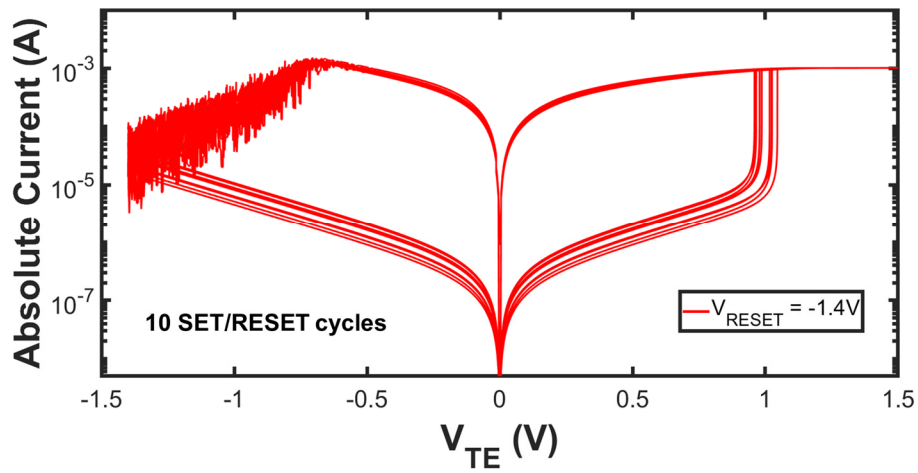


Fig. 4 - Results of the SET/RESET variability simulation considering 10 SET/RESET consecutive cycle using  $V_{\text{RESET}} = -1.4\text{V}$ .

Netlist: *RTN\_test.scs*

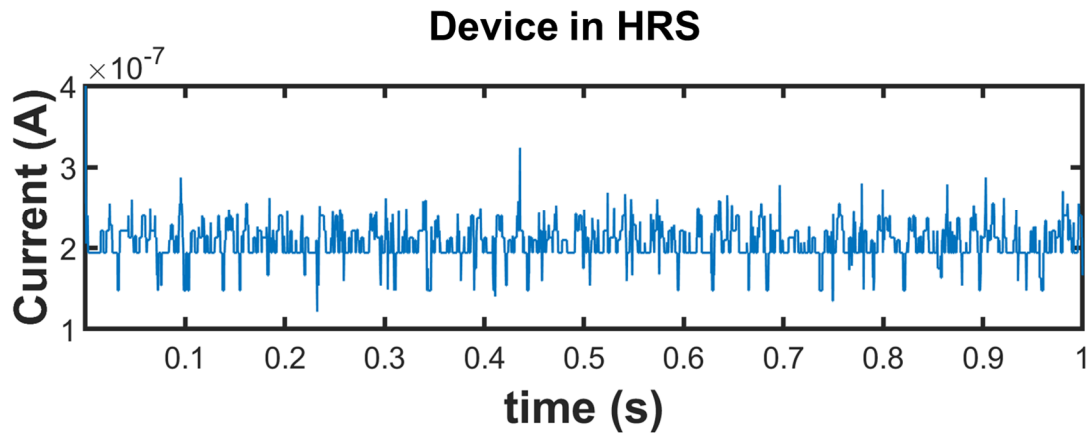


Fig. 5 – Example RTN traces considering the device in HRS (a) and LRS (b) when a constant 100mV read voltage is applied.

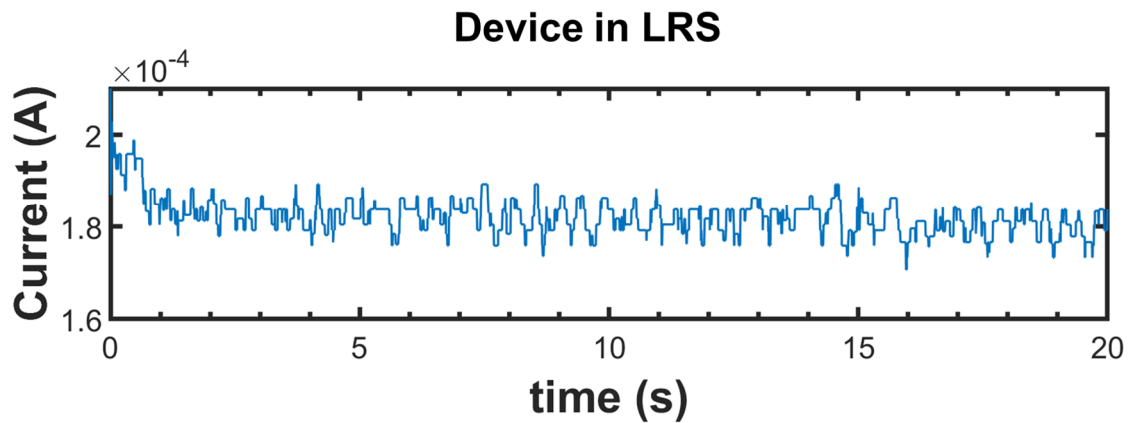


Fig. 6 – Example RTN trace with the in LRS when a constant 100mV read voltage is applied. The simulation parameter *x0* in the netlist file must be set to zero and the stop parameter of the transient simulation set to 20.

## References

- [1] S. Yu, B. Gao, Z. Fang, H. Yu, j. Kang and H.-S. P. Wong, "A neuromorphic visual system using RRAM synaptic devices with Sub-pJ energy and tolerance to variability: Experimental characterization and large-scale modeling," *2012 International Electron Devices Meeting, San Francisco, CA*, pp. 10.4.1-10.4.4, 2012. doi: 10.1109/IEDM.2012.6479018