Selective Electromigration as a Mechanism for Resistive Switching

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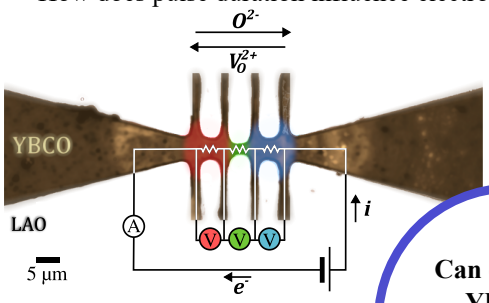
Introduction

Under large current densities, electromigration can change the resistance of YBCO microbridges by moving dopants (oxygen vacancies V_O^{2+}).

In the context of resistive memory applications:

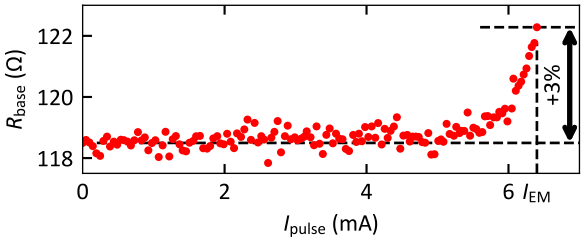
↳ How often can the resistance state be restored?

↳ How does pulse duration influence electromigration?



Electromigration

Momentum transfer between moving charge carriers and lattice ions can lead to ion displacement.



In the case of YBCO, only the oxygen ions are moved by electromigration. Since oxygen acts as a dopant, this movement can change the resistance.

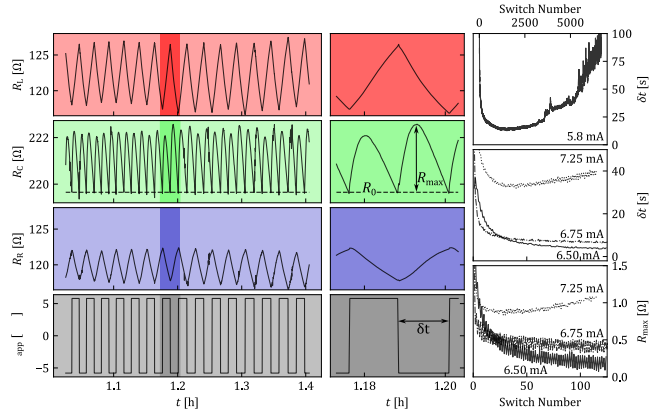
Can electromigration-induced resistance changes in YBCO microbridges enable memory and logic devices?

✓ Resistance changes are reversible.

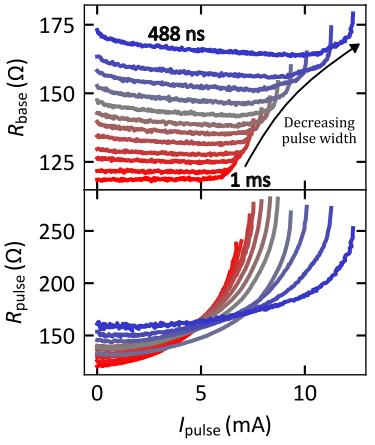
✓ The electromigration current depends strongly on pulse duration, offering tunability.

Resistive Switching Endurance (DC)

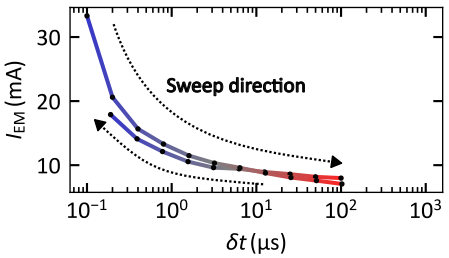
✓ Highly reversible
✓ Up to 10^4 switches
✗ Finally, oxygen channels break



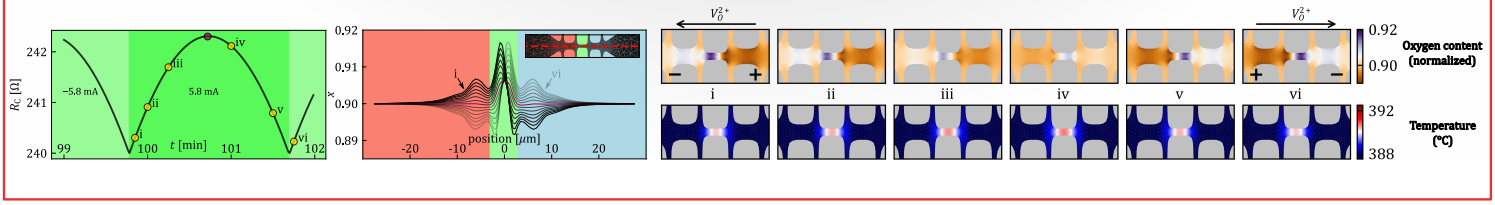
Pulse width



↳ longer pulses
↳ more Joule heating
↳ higher diffusion coefficient
↳ less current needed to electromigrate



FEM: Oxygen and Temperature maps



S. Marinković, D. Stoffels, et al., Electromigration-driven weak resistance switching in high-temperature superconducting devices. *Phys. Rev. B* 110, 165157 (2024).

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