# Transition Metal Oxide Resistive Memory

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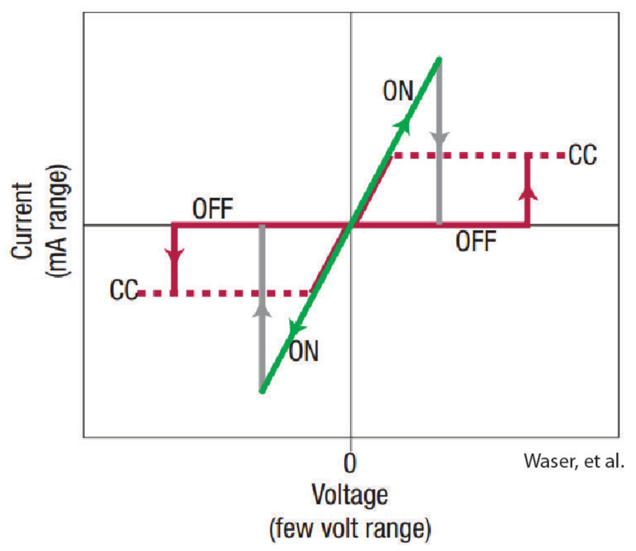
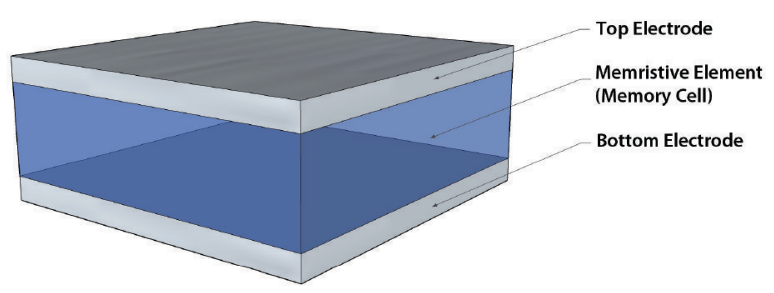
## Introduction

- NAND flash has reached fundamental scaling limits.
- To continue 2D scaling of memory, a new type of memory must be used.
- Resistive random access memory (RRAM) is a leading candidate to replace flash.
- In RRAM, a passive element stores information by changing resistance.
- Low current levels can be used to read the cell, and high currents or voltages can be used to program it.
- Devices which change their resistance state based on previous biasing conditions are called "memristive."

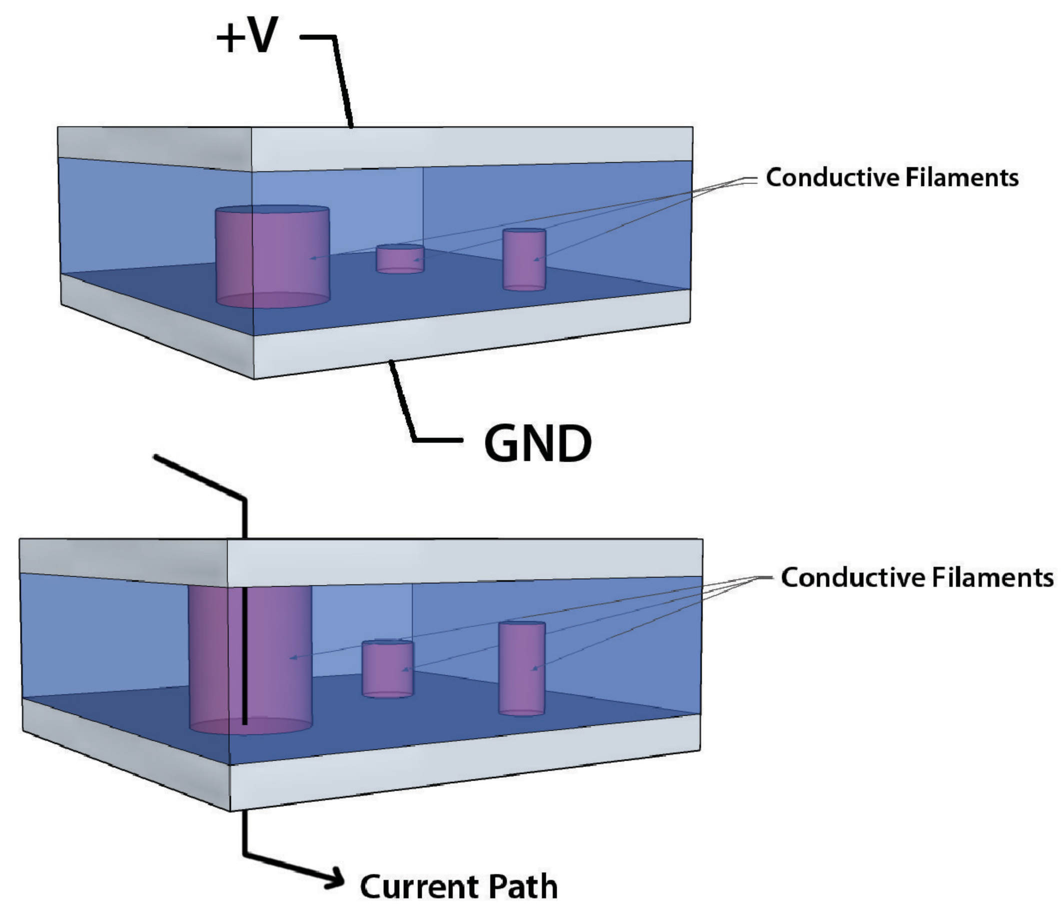



- Transition metal oxides are a class of materials which can change resistance by undergoing a reversible soft breakdown.
- These materials include titanium dioxide, hafnium dioxide, and nickel oxide.
- A process was created to fabricate devices which could investigate this memristive behavior.

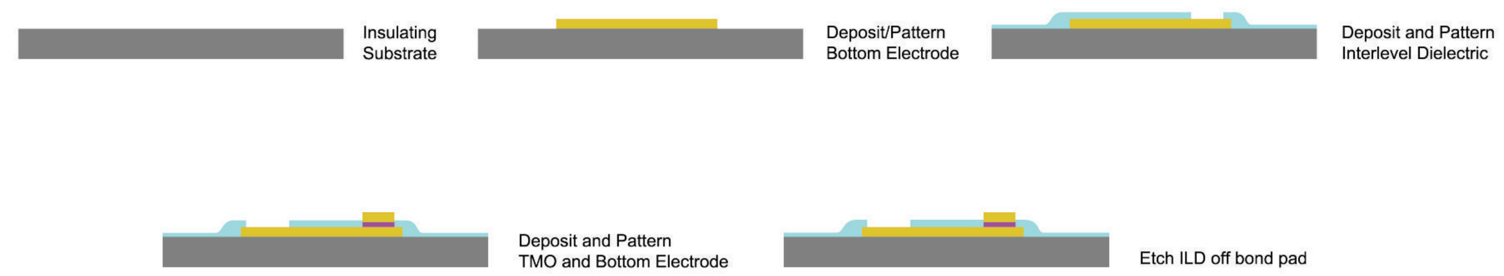
## Theory

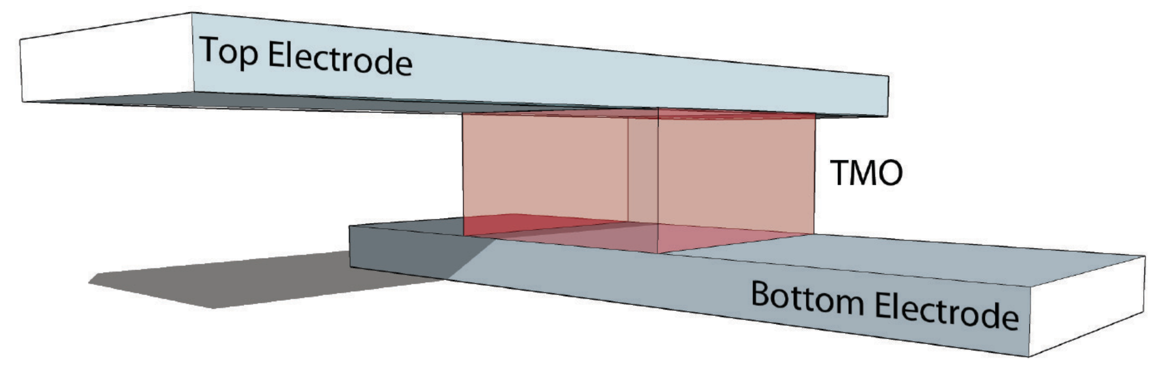
- A great deal of research has focused on titanium dioxide, making it the best-characterized memristive film.
- Titanium dioxide can form many phases, some of which are conductive and some of which are insulating.
- Under-stoichiometric films with oxygen vacancies are conductive.
- Electrical biasing can drive a reaction to create oxygen vacancies.
- These vacancies can rearrange into filaments which conduct current through the material.
- High currents passed through the filaments causes them to heat, which causes the filament to react and/or dissipate.



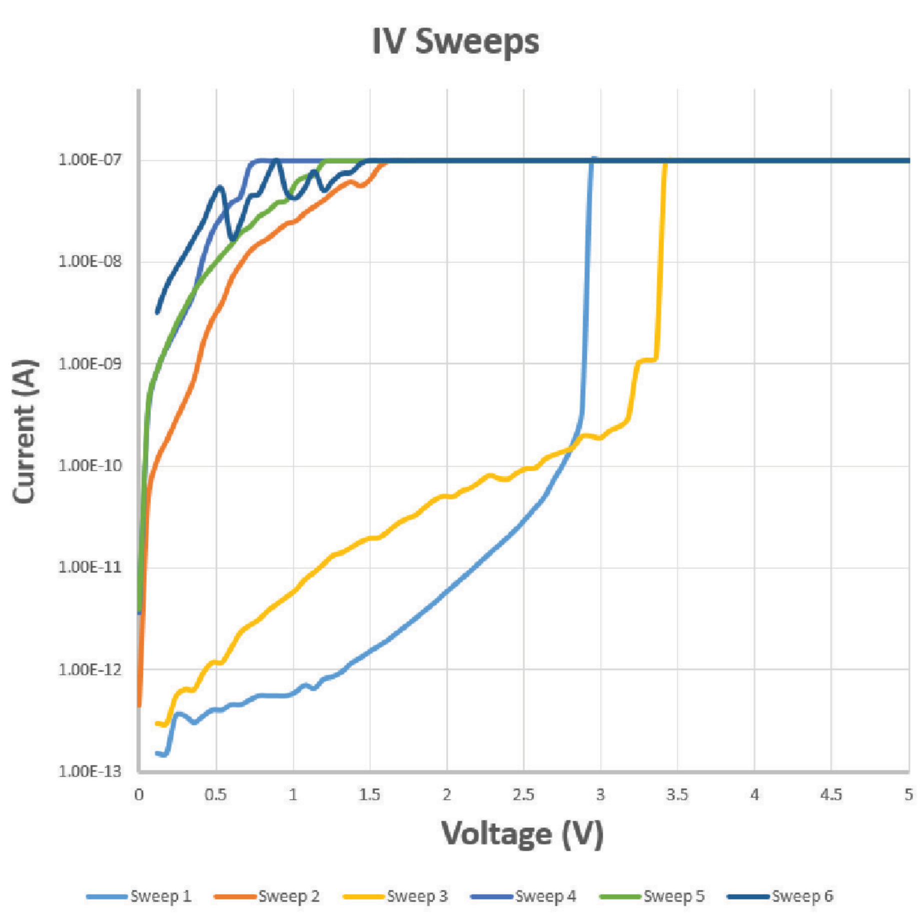

## Process

1. Prepare insulating substrate
2. Deposit and pattern bottom electrode
3. Deposit and pattern inter-layer dielectric
4. Deposit memristive transition metal oxide (TMO) film
5. Deposit and pattern top electrode
6. Etch interlevel dielectric over bond pad
7. Electrical test

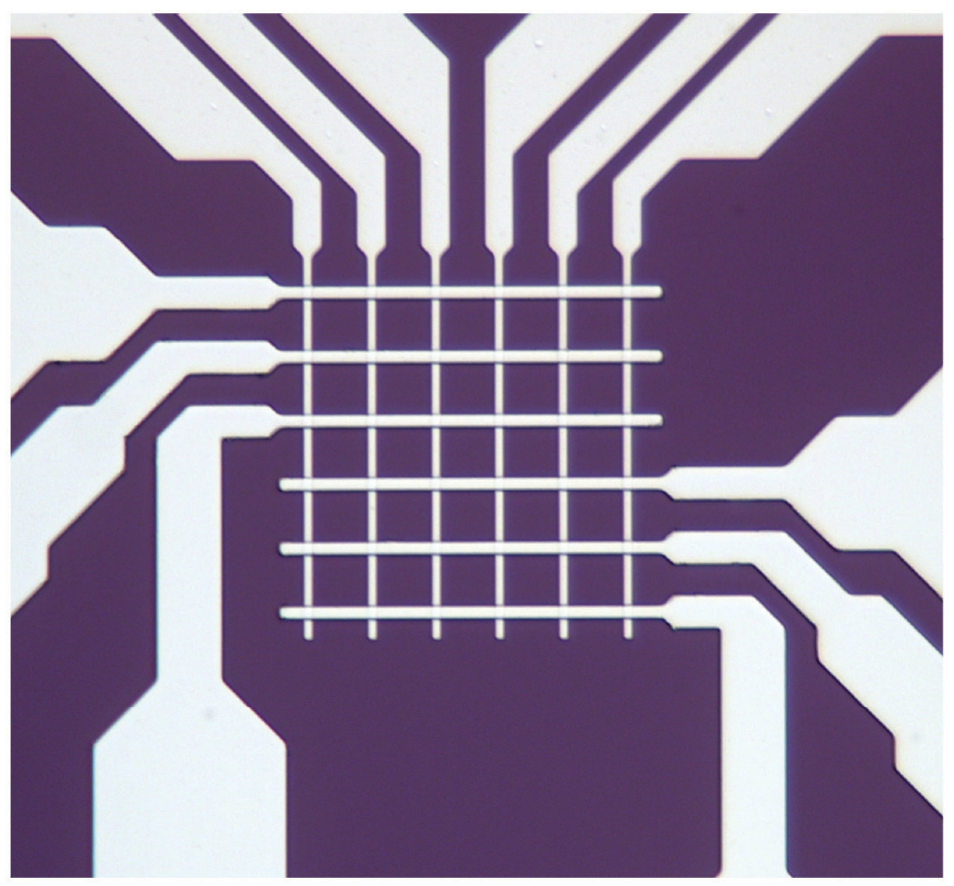


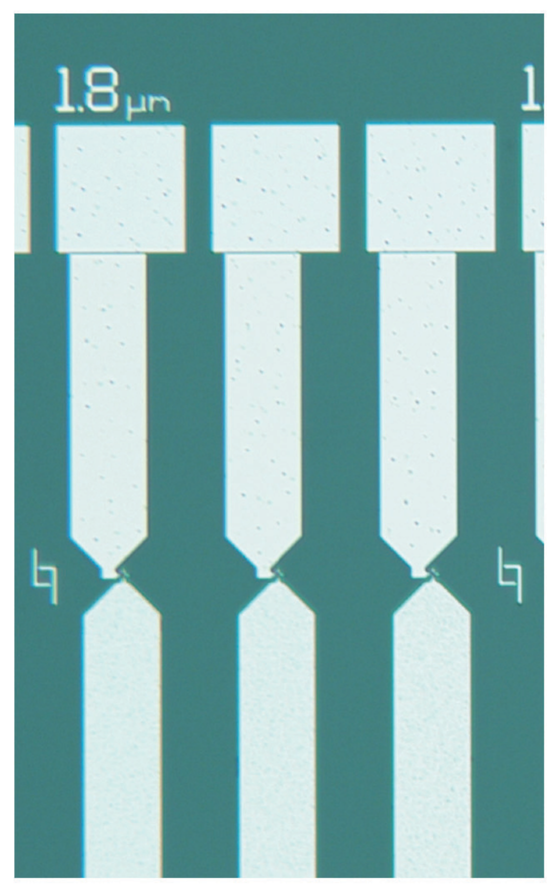




## Results




- Devices were created using aluminum top and bottom electrodes and a under-stoichiometric titanium oxide film.
- Electrical testing confirmed that the structures could switch between a high and low resistance state.
- On average, the on/off ratio was $10^4$ at 1 V.






## References & Acknowledgements

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