MOHJO™

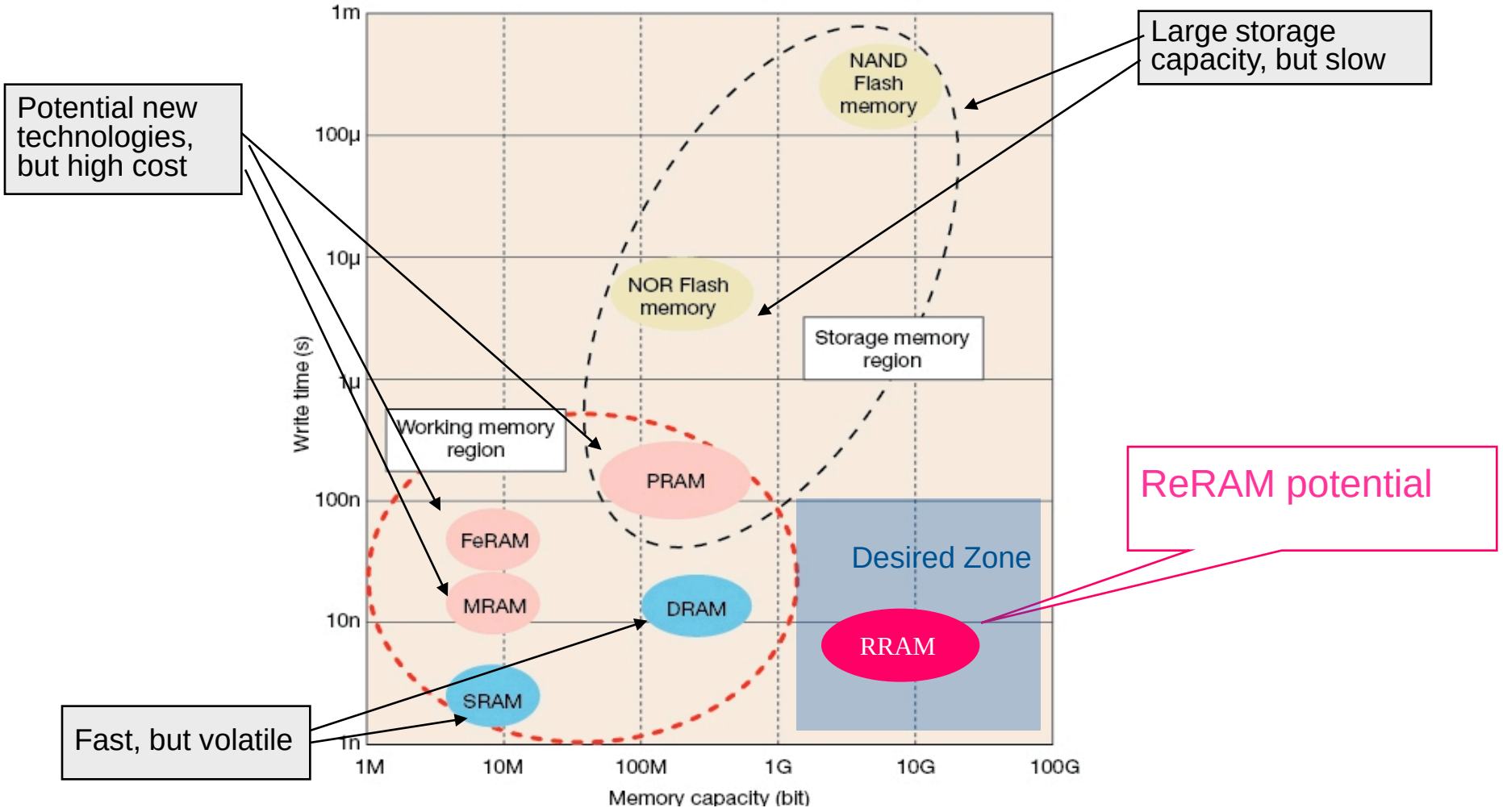
Metal Oxide Hetero Junction Operation Nonvolatile Memory

Lee Cleveland

Director of Device Engineering

4DS, Inc.

Next Generation of Nonvolatile Memory



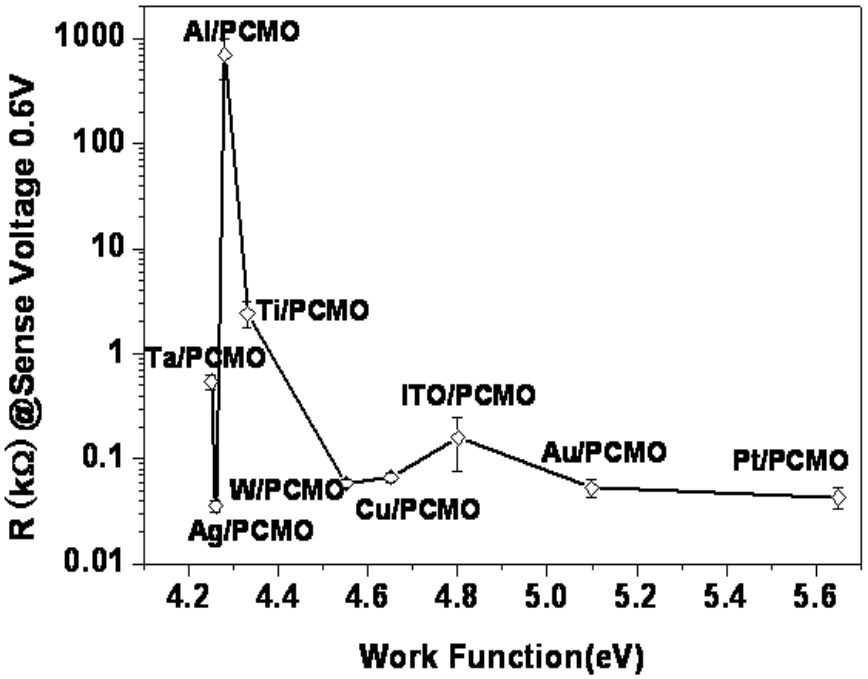
Source: Nikkei Electronics

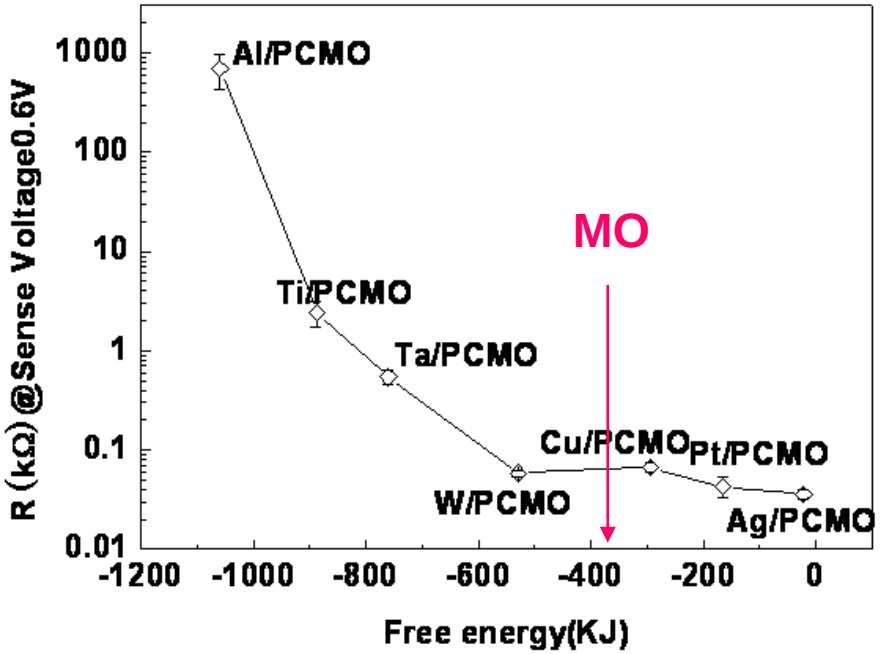
Role of Electrode Materials in Bipolar Resistive Switching Devices

Classification of MOHJO devices

	Free energy	Device Structure
Type - I	**> MOHJO**	**M/MO/M**
Type - II	**< MOHJO**	**M/MO/MO/M**

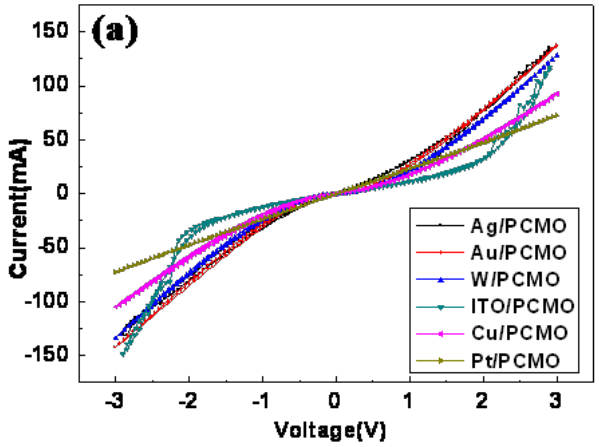
Liao/Chen et al, Appl. Phys. Lett. 94, 253503 (2009).

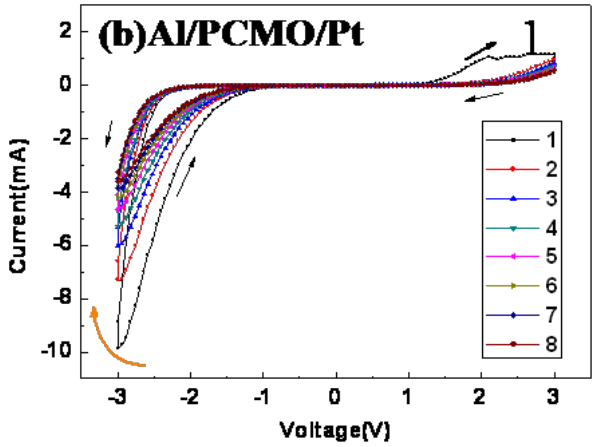


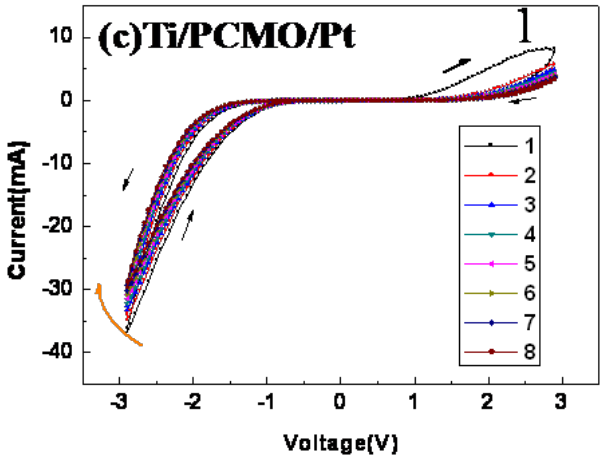


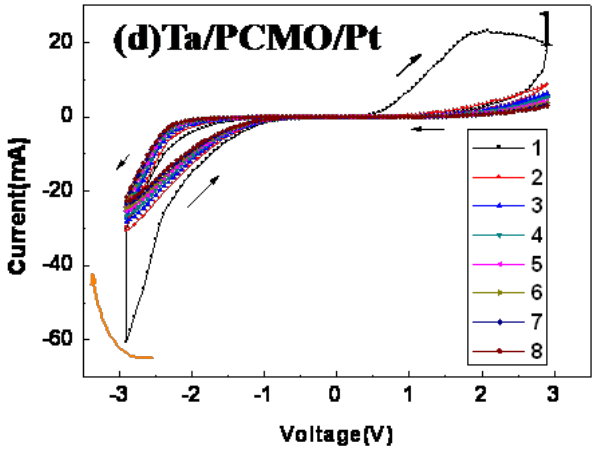
Liao/Chen et al, Appl. Phys. Lett. 94, 253503 (2009).

I-V Loop



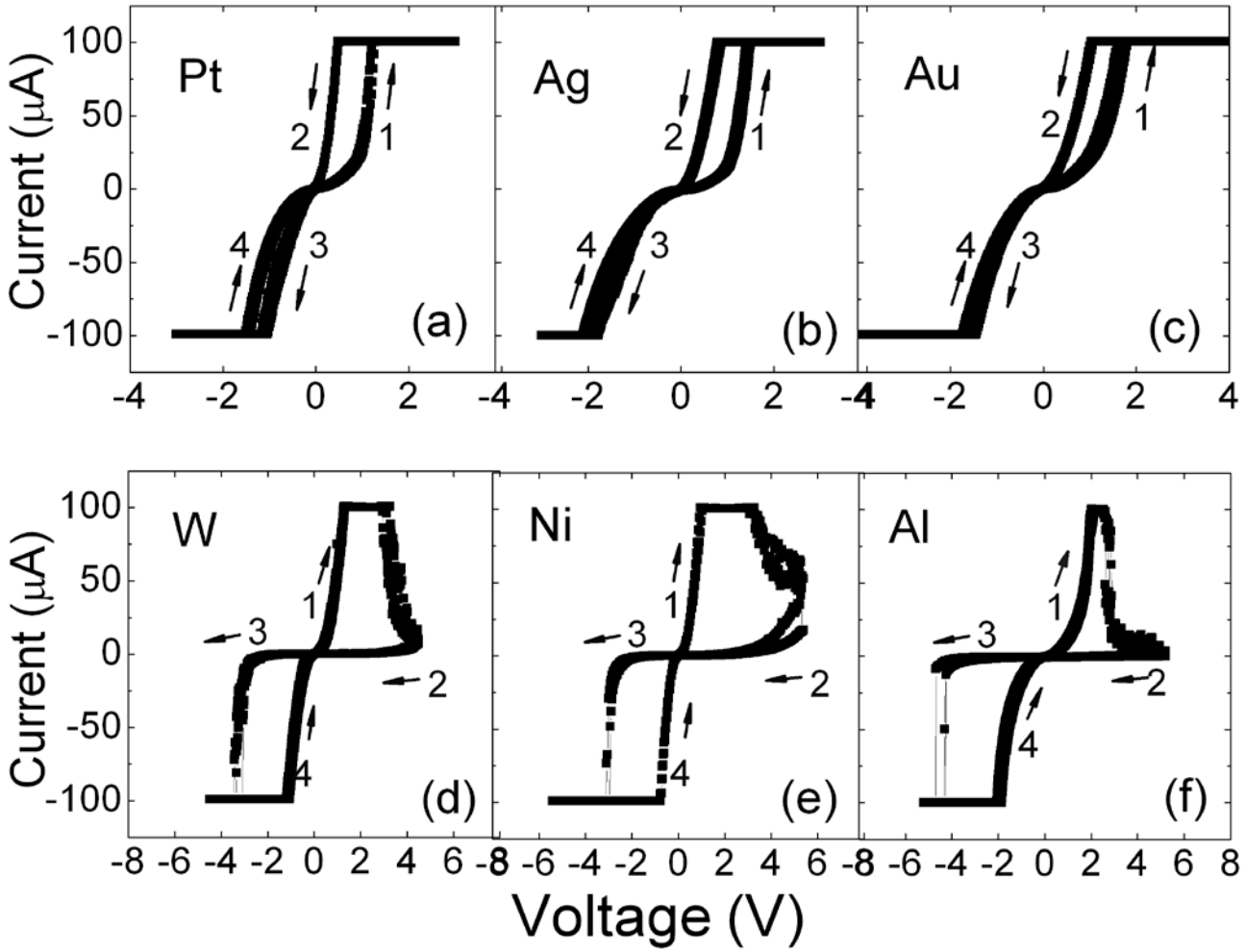


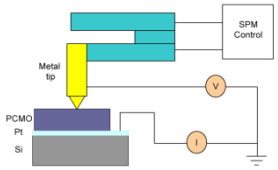




Liao/Chen et al, Appl. Phys. Lett. 94, 253503 (2009).

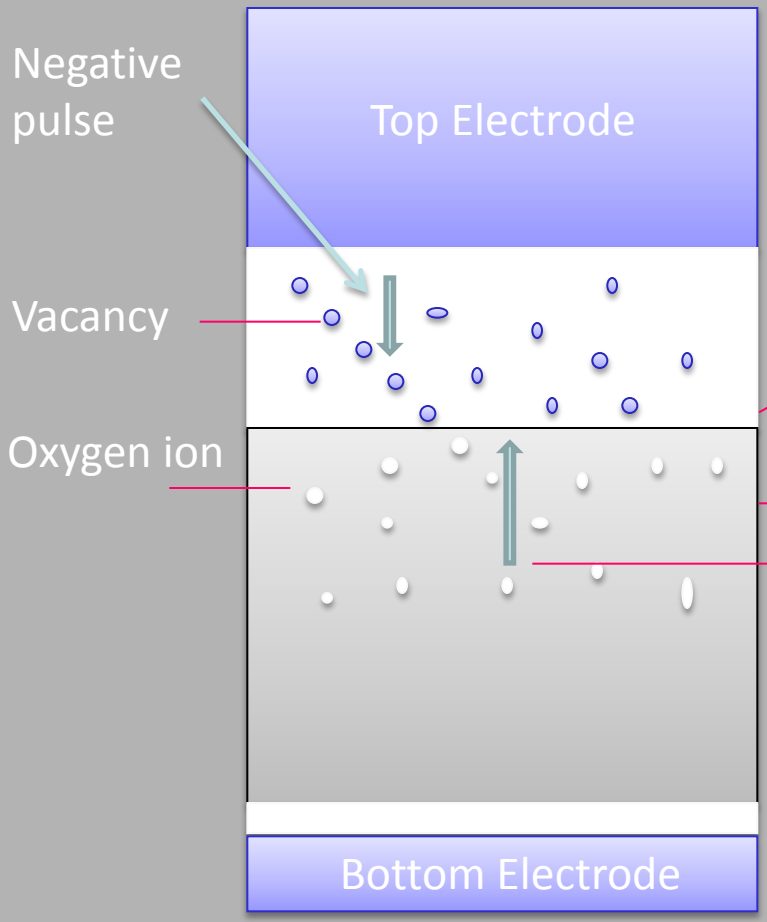
Clock vs Counter Clockwise Loop





Gang/Chen et al., CHIN. PHYS. LETT. 27, No. 2 027301 (2010).

Type-I device: PCMO with non-reactive metal TE

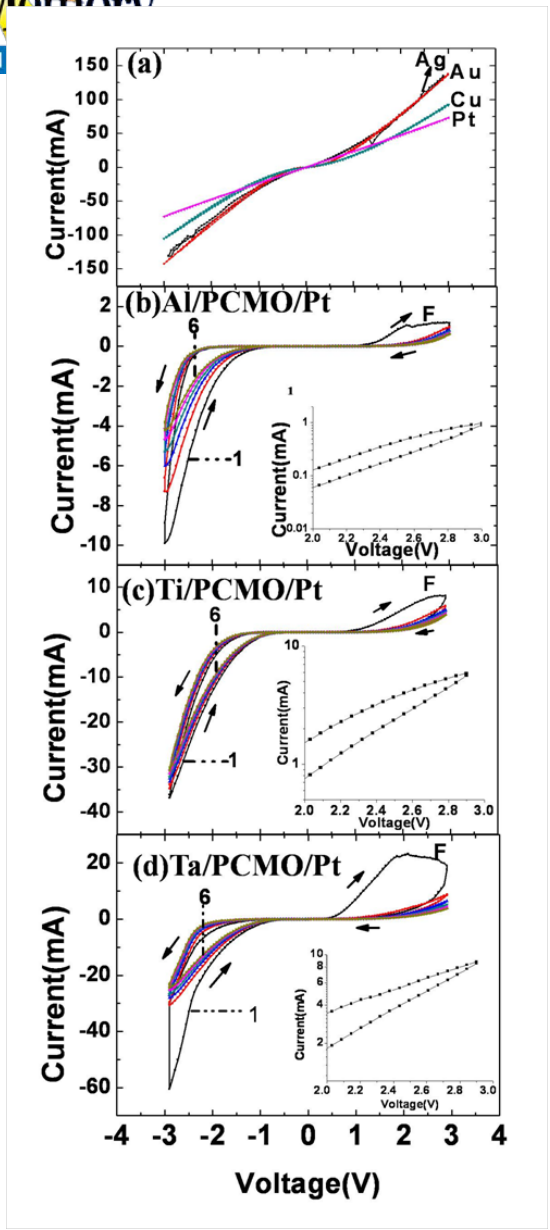


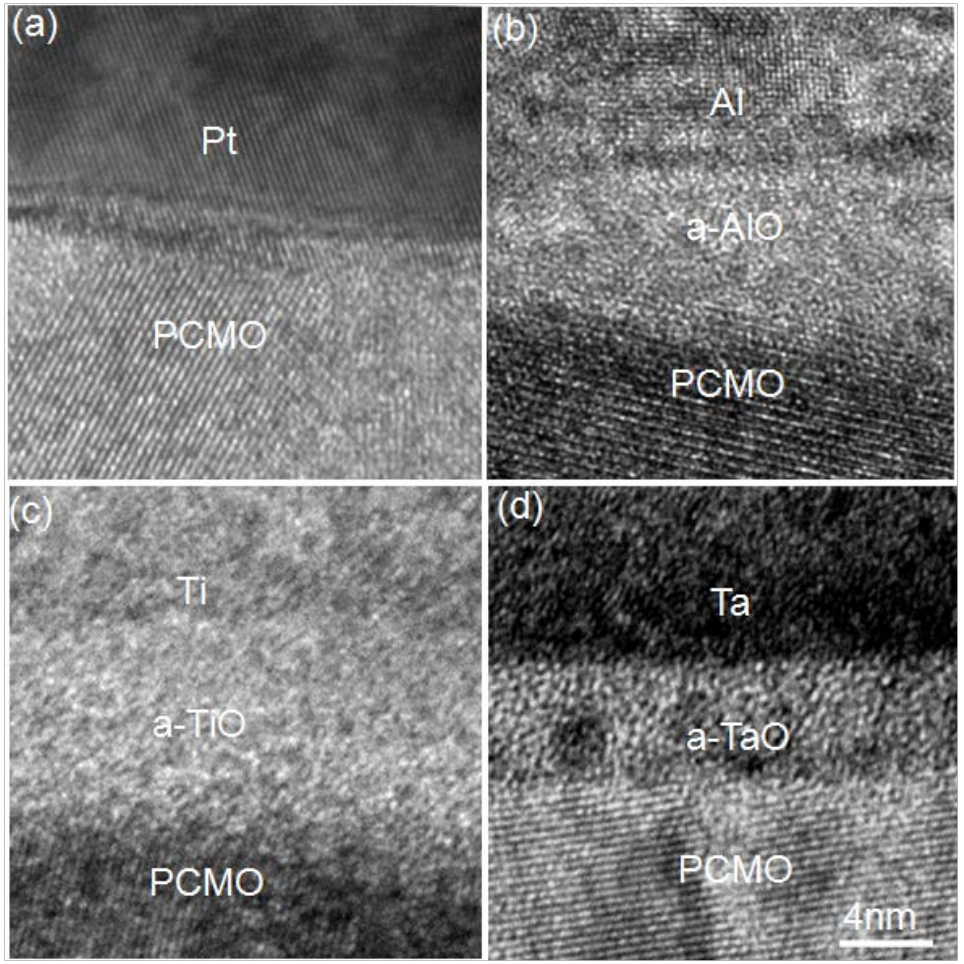
Interface Between the top electrode and the perovskite oxide film

Pervoskite film

Positive Pulse

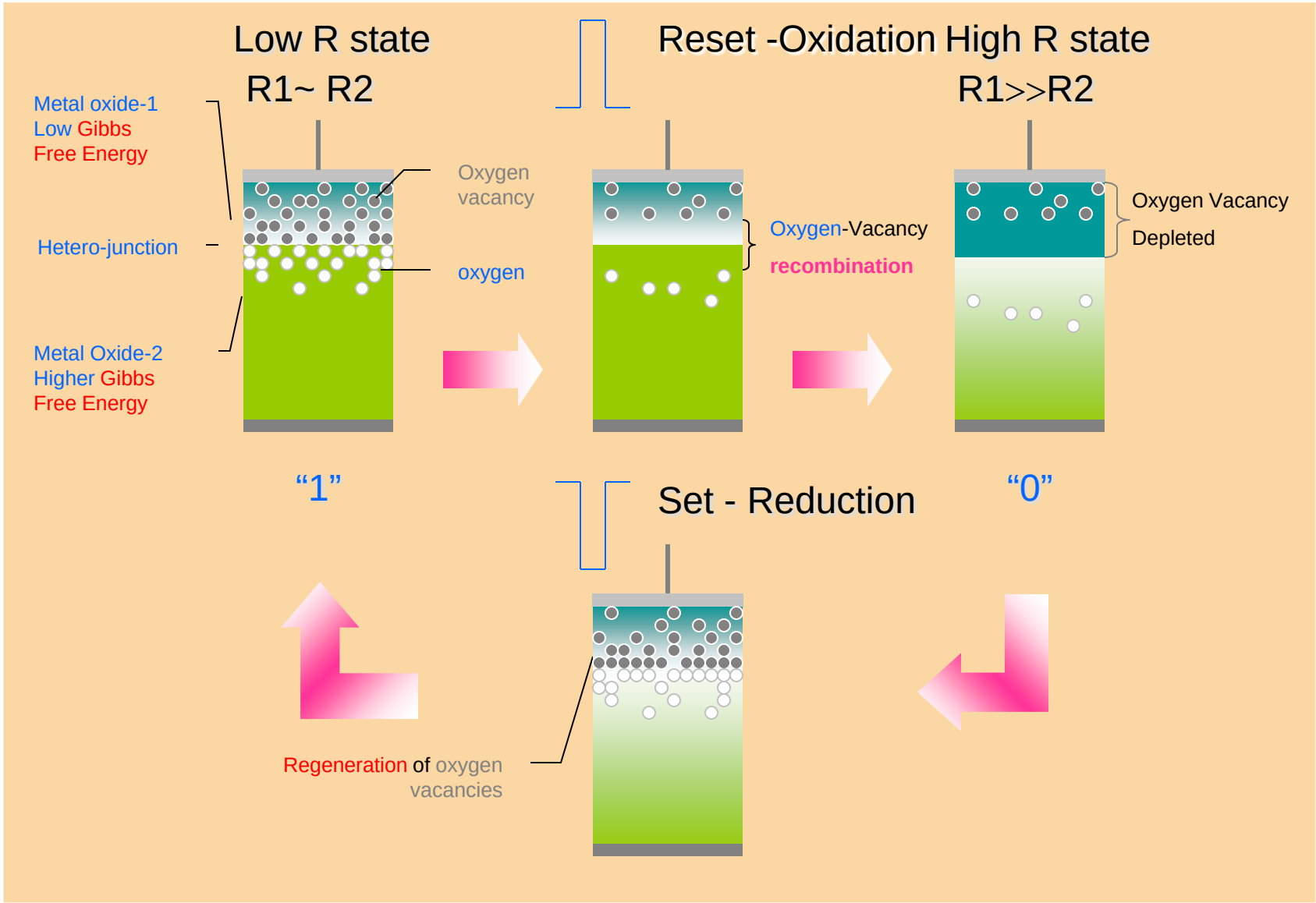
A positive V pulse will move the oxygen ion into the vacancies Located near the metal electrode interface and patching otherwise breaking M-O-M-O chains and thereby decrease the resistance while the negative pulse will movie the oxygen vacancies into the interface region, and piling them up at metal interface, and increase the resistance.



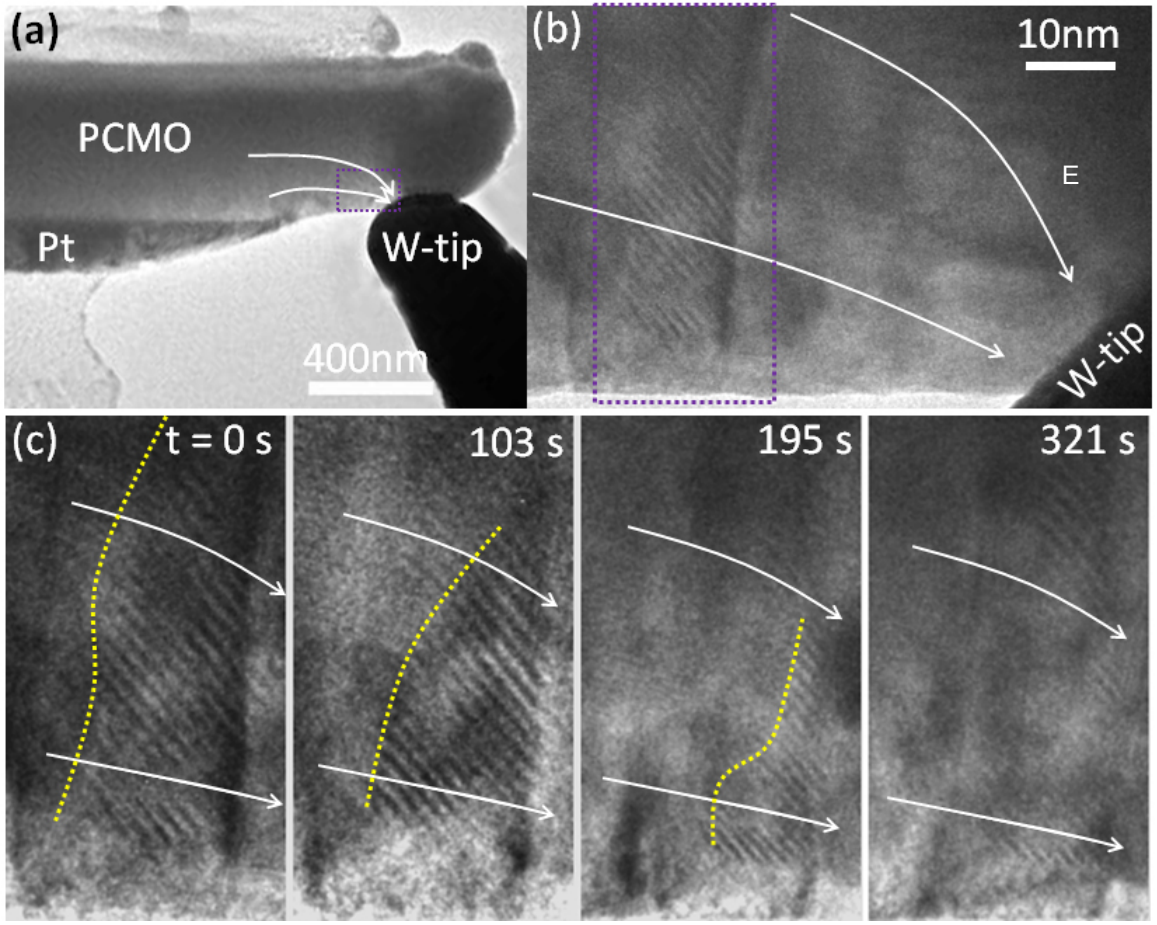


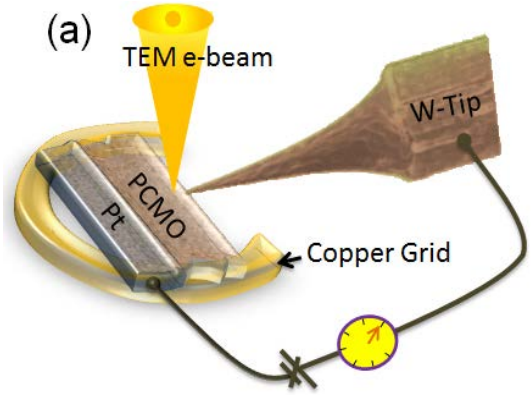
Liao/Chen et al, Appl. Phys. Lett. 94, 253503 (2009)

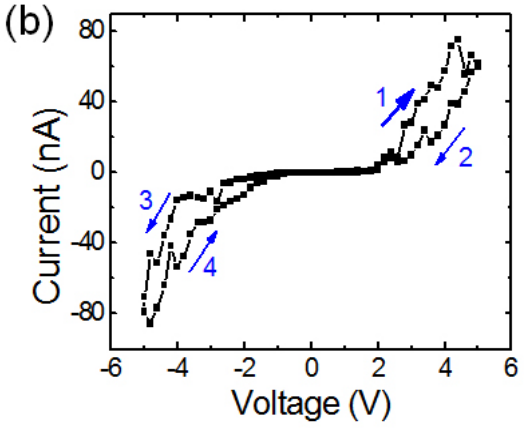
Type –II device: Metal Oxide Heterojunction Operation

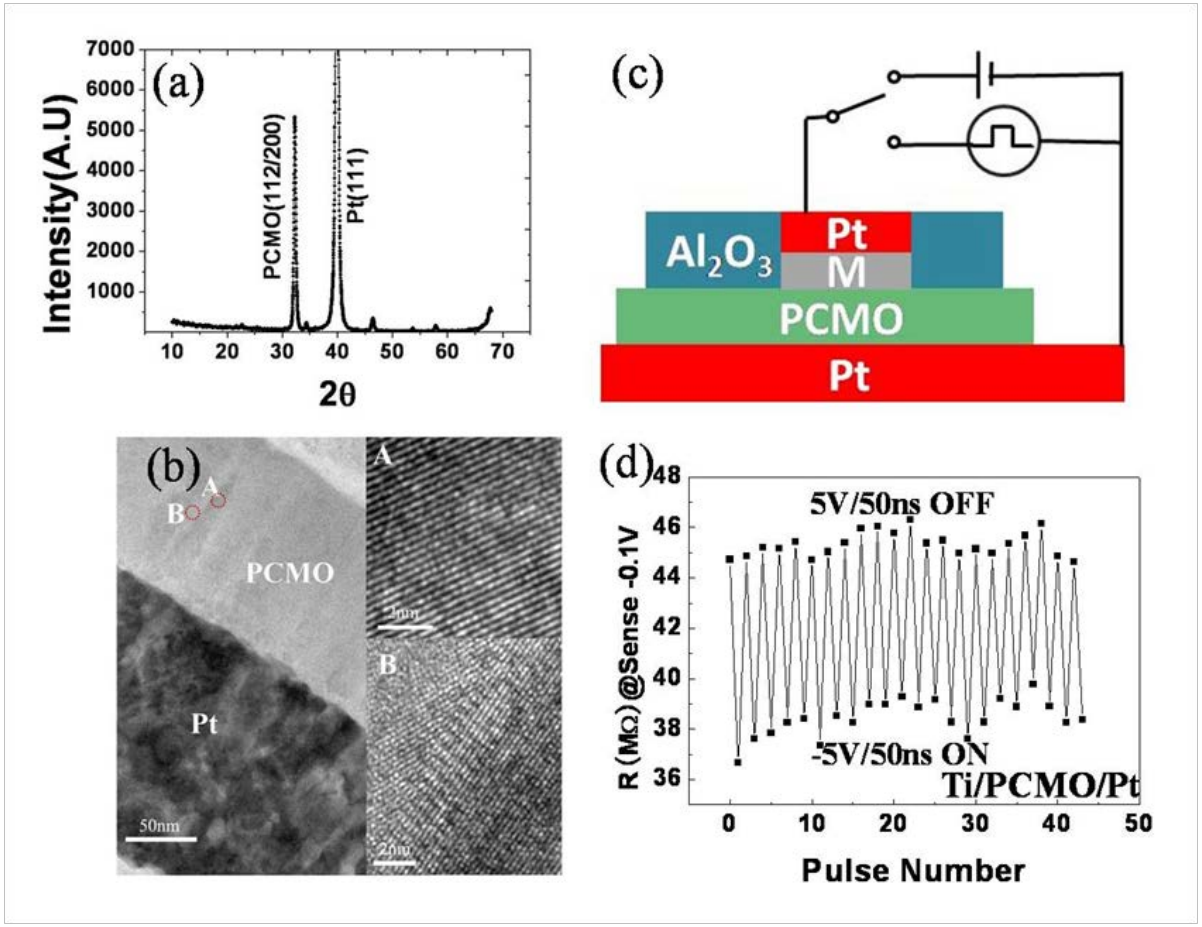


In situ TEM Observation of Oxygen Vacancy Motion









4DS proprietary process yields columnar polycrystalline PCMO which is fully CMOS compatible & high throughput

Metal Oxide Heterojunction	P-N Junction
Gibbs Energy	Fermi energy
Space vacancy formation	Space charge formation
Ion migration	Charge drift
Field and temperature sensitive	Field and temperature sensitive
Metastable or Chemical reaction	Field dependent

Characteristics of MOHJO devices

	TYPE-I	TYPE-II
ΔR	Small	Large
Response time	fast	fast
Retention	Good	Excellent
Endurance	Good	Good
Tunable	Poor	Excellent