

# Rewritable Electrical Memory Effect in Poly[N-(3-(9H-carbazole-9-yl)propyl)methacrylamide](PCaPMA)

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A memristor is principally a resistor-like device composed of an active layer sandwiched between two electrodes whose resistance is dependent on the magnitude and direction of the previously applied voltage, and exhibits at least two distinct electrical conductance states. These states can be assigned to binary state of logic 0 and logic 1. The devices can be used in switching, high-density information storage, neuromorphic computing and synaptic learning.

Here, we report on synthesis of poly[N-(3-(9H-carbazole-9-yl)propyl)methacrylamide] (PCaPMA), and its photophysical and electrical properties. Thin films of the PCaPMA sandwiched between two metal electrodes exhibit bi-stable resistance with an ON/OFF ratio exceeding 100, good reproducibility and persistence ability. Memristive behaviour has been assigned to charge trapping and stabilization of voltage-induced conformational changes by physical crosslinking via hydrogen bonds between amide and carbonyl groups.

## Synthesis of PCaPMA

### a. Monomer synthesis

#### N-(3-(9H-carbazol-9-yl)propyl)methacrylamide (CaPMA):

##### i. Carbazole

- (+ acrylonitrile+ benzyltrimethyl- ammonium hydroxide)
- Cooled to 0–5 °C → Rxn temperature increased to 70 °C
- Yellow crystals were filtered off after cooling, and the mother liquor was reduced to get a second crop of crystals.

##### ii. 3-(9H-Carbazol-9-yl)propanenitrile

(+dioxane+Raney Nickel)

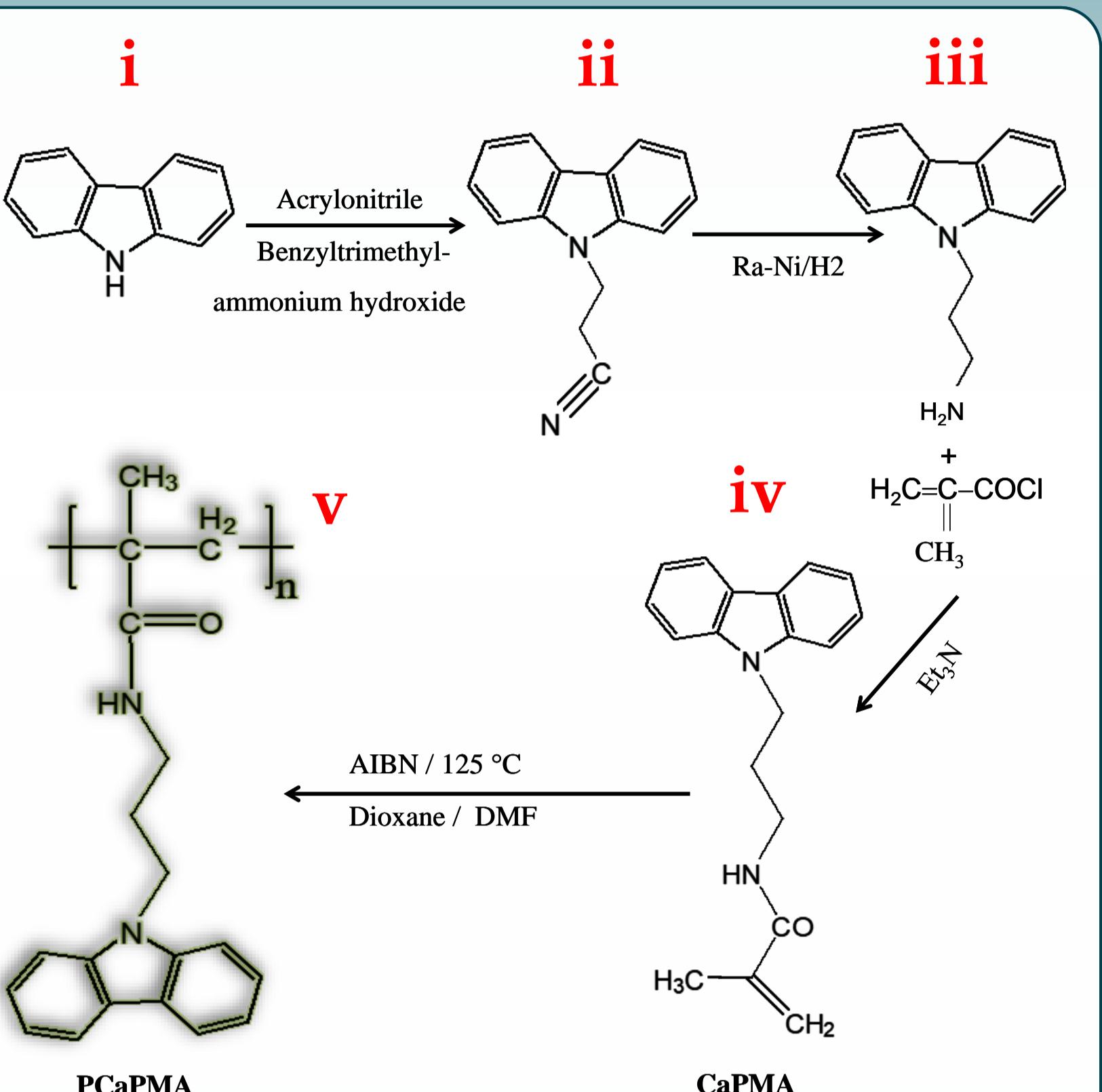
- Catalytic reduction by hydrogen.
- The Raney nickel was filtered off, and dioxane was removed by a rotavapor.
- The amine was vacuum distilled to give a viscous fluorescent liquid that solidifies.

##### iii. 3-(9H-Carbazol-9-yl)propan-1-amine

(+ methacryloyl chloride + trimethylamine)

- Increased white suspension was stirred and filtered off.
- The white suspension was washed with water to remove trimethylamine hydrochloride.
- Raw material was crystallized from ethanol (charcoal) to give a white crystal of the title compound.

##### iv. N-(3-(9H-carbazol-9-yl)propyl)methacrylamide

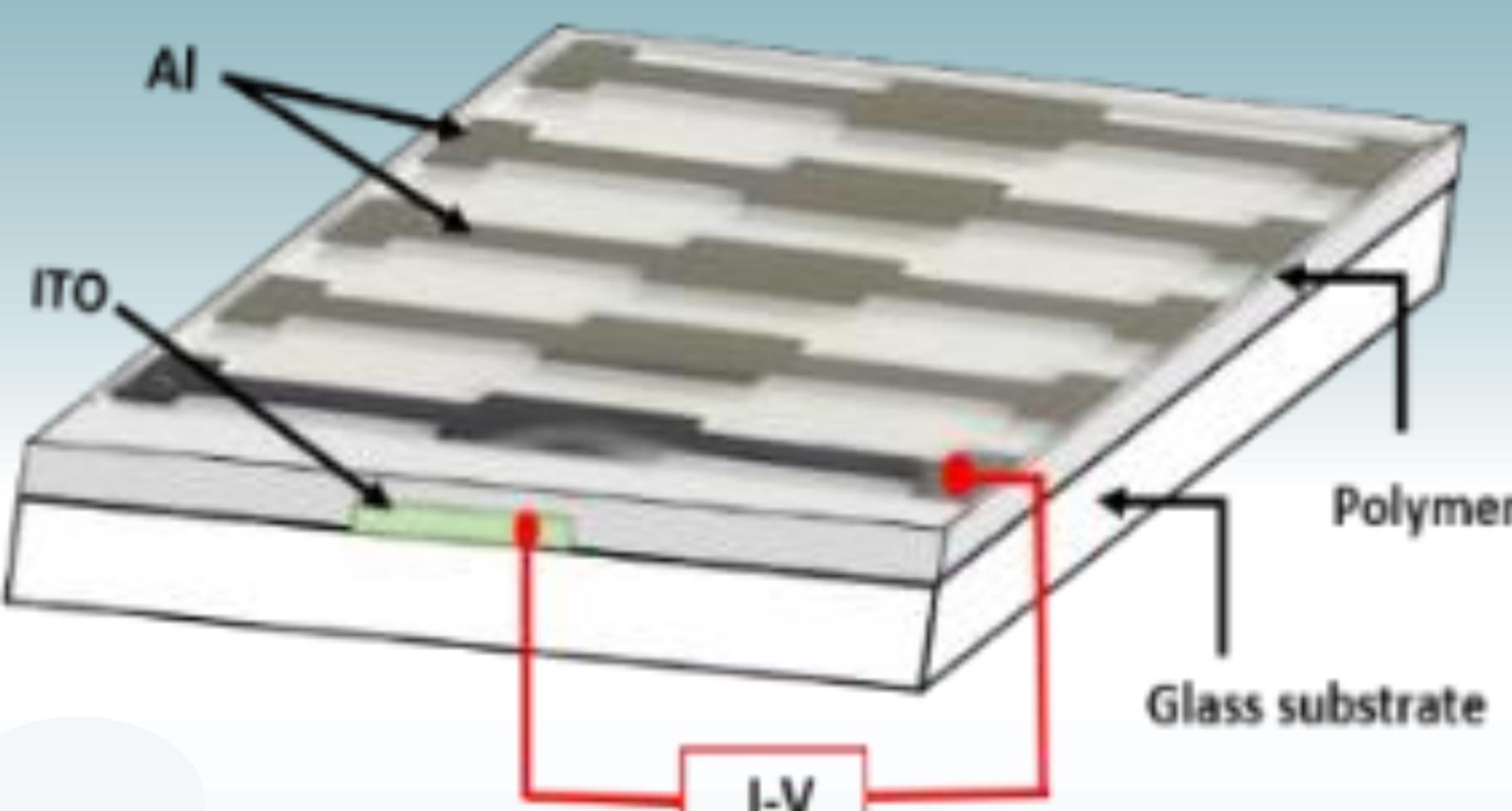


### b. Polymerization

#### N-(3-(9H-carbazol-9-yl)propyl)methacrylamide (+ AIBN+dioxane +DMF)

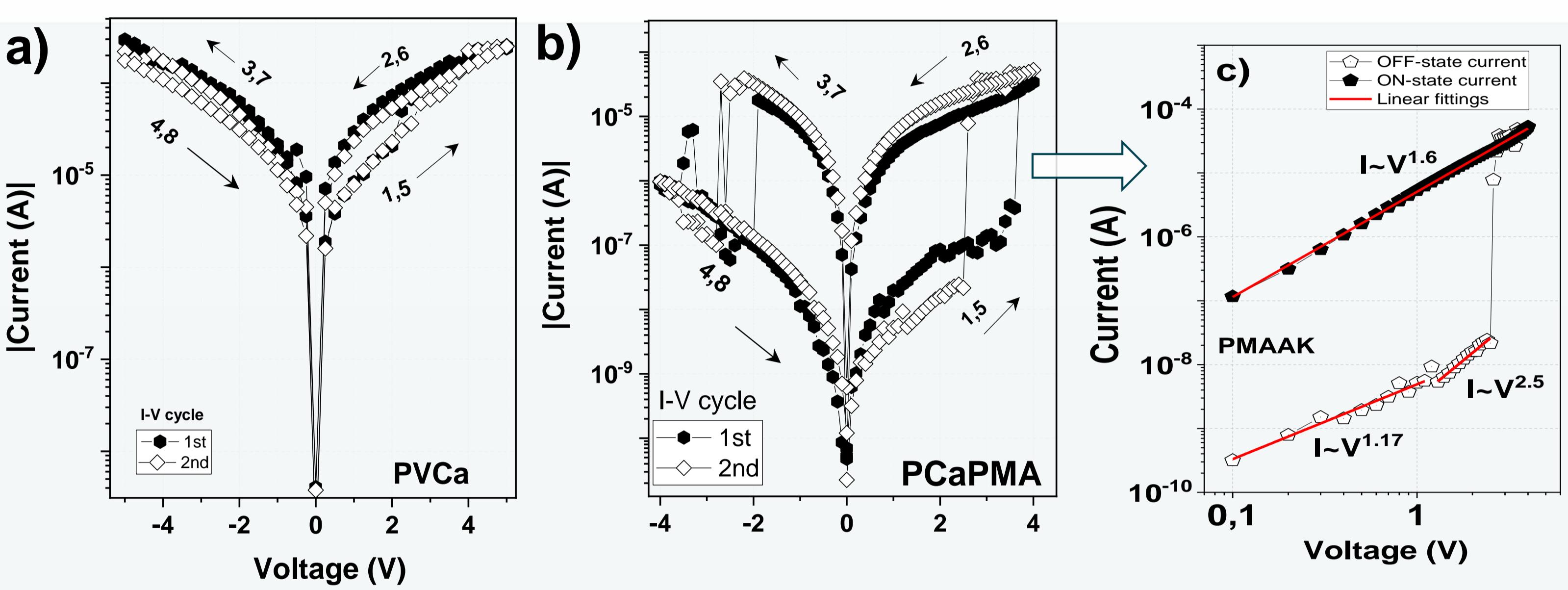
- Mixed compounds were sealed in an ampoule under argon and heated.
- Content of ampoule was precipitated into diethyl ether.
- Raw white polymer was filtered off and reprecipitated.
- The white polymer was left for sedimentation, then filtered off and dried.

##### v. PCaPMA



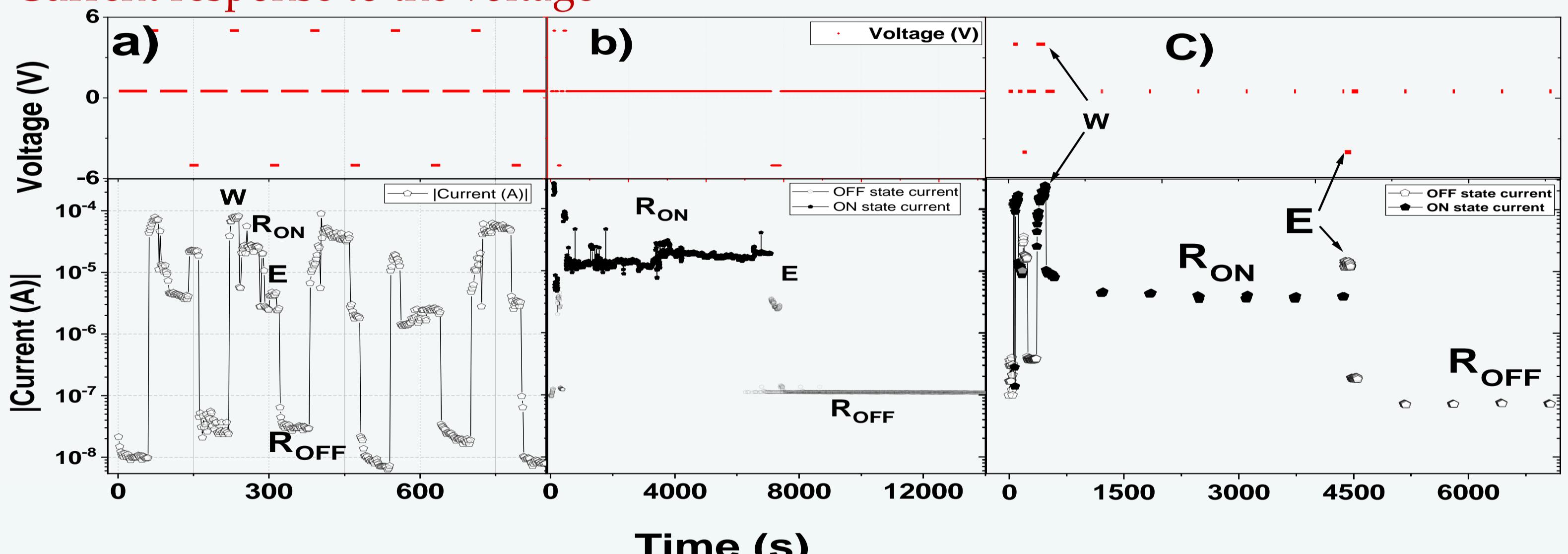
Schematic structure of the memory device: Al as the top electrodes and ITO as the bottom electrode perpendicular to Al.

## Electrical characterization (Memory effect)



I-V cycles of a) ITO/PVCA/Al and b) ITO/PCaPMA/Al devices in two continuous cycles, sweep order indicated by respective arrows. c) linear fittings of first I-V cycle of PCaPMA in log-log scale for the illustration of transport properties.

### Current response to the voltage



a) Write-read-erase-reread (WRER) cycles, b) Retention performance, c) Volatility test of memory device

