Coexistence of Nonvolatile Unipolar Memory and Volatile Threshold Resistance Switching In LaMnO$_3$ Thin Films

**CURRENT STATUS:** POSTED

yanfeng Yin  
Henan University  
_corresponding author_  
ORCiD: https://orcid.org/0000-0001-6618-412X

ying Zhang  
Henan University

caihong Jia  
Henan University

weifeng Zhang  
Henan University

**DOI:**  
10.21203/rs.3.rs-17337/v1

**SUBJECT AREAS**  
Nanoscience

**KEYWORDS**  
Unipolar resistance switching, Threshold resistance switching, Oxygen vacancies, Insulator-to-metal transition
Abstract
Coexistence of nonvolatile unipolar memory and volatile threshold resistive switching was observed in Pt/LaMnO₃/Pt system. Specifically, nonvolatile unipolar memory was achieved by applying a negative bias, while volatile threshold resistive switching was obtained at a positive bias. The formation/rupture of conducting filaments and insulator-metal transition are supposed to induce nonvolatile unipolar memory and volatile threshold resistive switching, respectively. The convenient transition between nonvolatile and volatile switching by polarity is very useful for applications in in-memory computing technology.

Full Text
Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures
Figure 1

a XRD pattern of LMO film, the inset shows the structure diagram of the device. b The atomic force microscope image of the LMO film. c Cross-sectional SEM image of the LMO film deposited on Pt/Ti/SiO2/Si substrate. d The initial positive reset I-V curves of Pt/LaMnO3/Pt device, the upper left and lower right insets show the low resistance state and high resistance state I-V curves measured over ±2 V range, respectively.
Figure 2

a 1000 consecutive positive bias volatile threshold switching cycles. b The statistical distribution of the $V_{th}$ and $V_{hold}$ with the number of cycles, the black solid line corresponds to a Lorentz fit curve of $V_{th}$. c The cumulative distribution of the $V_{th}$ and $V_{hold}$. d The $V_{th}$ and $V_{hold}$ as a function of the number of cycles.
Figure 3

(a) 500 cycles of nonvolatile negative bias unipolar switching. b Statistical distribution of Vset and Vreset with the number of cycles, the red and black solid lines are corresponding to the Lorentz fit curves. c The cumulative distribution of the Vset and Vreset. d Endurance test of LRS and HRS obtained with a reading voltage of -0.3 V.
The schematic energy band structure of initial positive high resistance state and negative low resistance state (a, d). The schematic diagram of the threshold switching (b, c) and the unipolar switching (e, f). In diagram, the “plus” and “minus” symbols represent positive and negative polarity of voltage, respectively. The “circled plus” symbols represent the ionized oxygen vacancies. The dark arrows show the drifting direction of the ionized oxygen vacancies. The “hollow circle” symbols represent the oxygen vacancies. In (b)(c)(e) and (f), the schematic distribution of metallic (black) and insulating (light blue) domains; the orange and black line represent the top and bottom Pt electrode, respectively.
