

Supporting Information

Cluster-Type Filaments Induced by Doping in Low-Operation-Current Conductive Bridge Random Access Memory

Yiming Sun, Cheng Song, Siqi Yin, Leilei Qiao, Qin Wan, Jialu Liu, Rui Wang, Fei Zeng and
Feng Pan**

Key Laboratory of Advanced Materials (MOE), School of Materials Science and
Engineering, Tsinghua University, Beijing 100084, China

E-mail: songcheng@mail.tsinghua.edu.cn, panf@mail.tsinghua.edu.cn

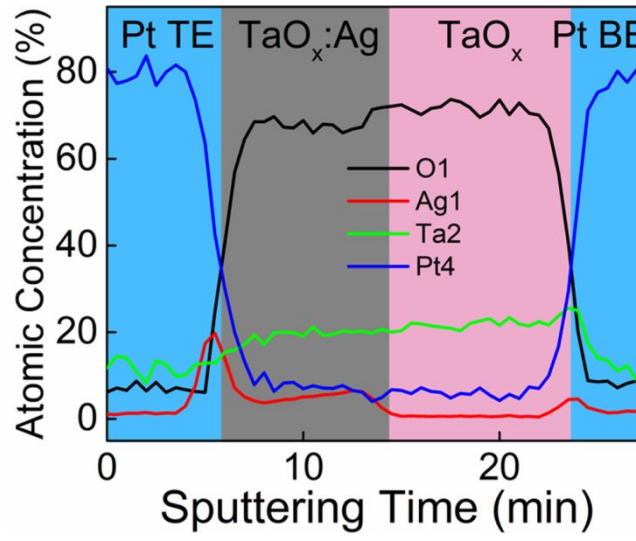


Figure S1. The atomic concentration in different depths in the initial state of Pt/TaO_x:Ag/TaO_x/Pt measured in the depth profile of auger electron spectroscopy. The location of each layer is marked by different color blocks.

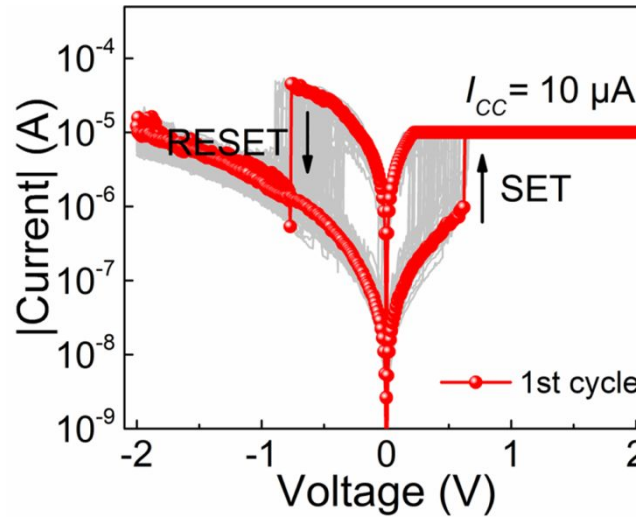


Figure S2. Resistive switching I - V curves at the compliance current of 10 μ A including 1st cycle (red ball symbols) and subsequent 50 operations (gray curves).

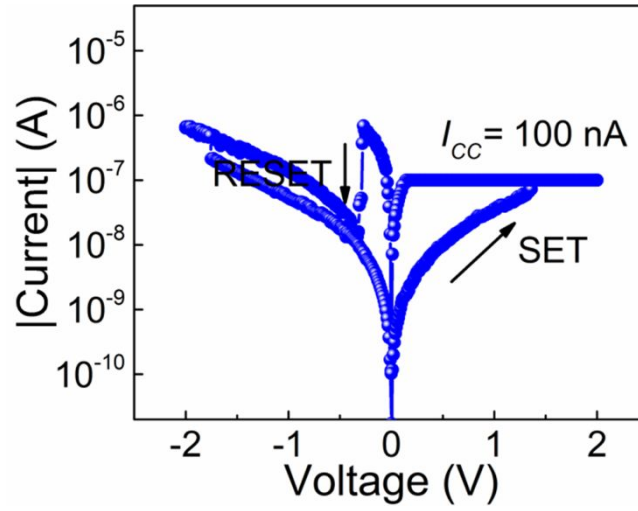


Figure S3. Resistive switching I - V curve at the compliance current of 100 nA.

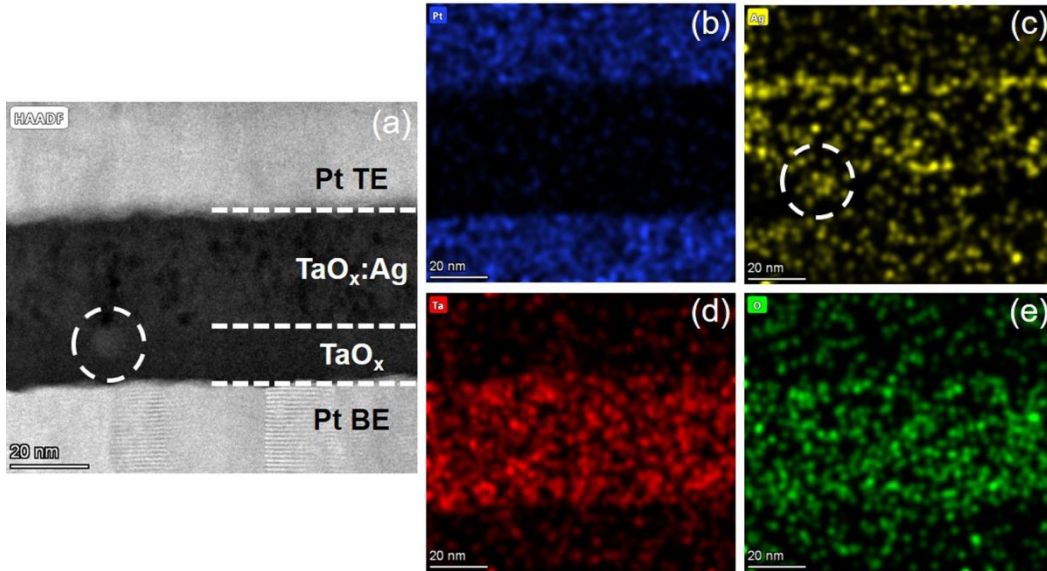


Figure S4. Mapping scan of energy dispersive X-ray analysis (EDX) of the Pt/TaO_x:Ag/TaO_x/Pt memory cell revealing the morphology and composition of conductive filaments. (a) High-angle annular dark field (HAADF) TEM image for EDX mapping scan. The multilayers are lined out. The map scanning results of (b) Pt, (c) Ag, (d) Ta and (e) O elements. The results demonstrate the clear interfaces between electrodes and dielectrics. A Ag cluster in the undoped TaO_x layer is marked by a dotted white circle and the corresponding accumulation of pixels is shown in Ag element (Figure S4c), proving the morphology of conductive filaments and the composition of the clusters.

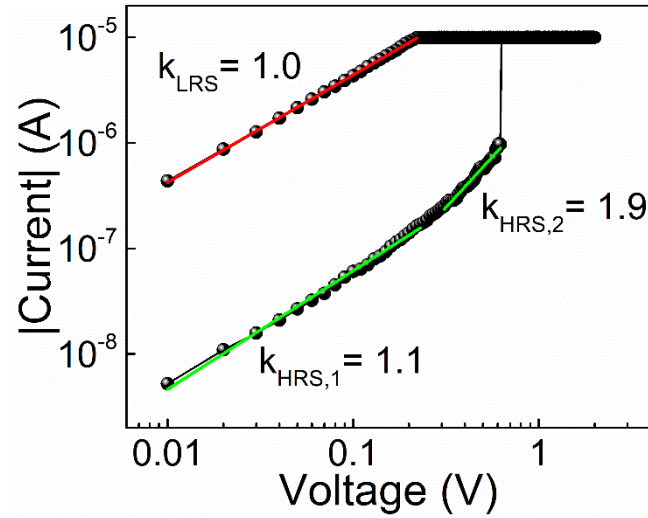


Figure S5. Log I –Log V curves of the LRS and HRS of the Pt/TaO_x:Ag/TaO_x/Pt cells.

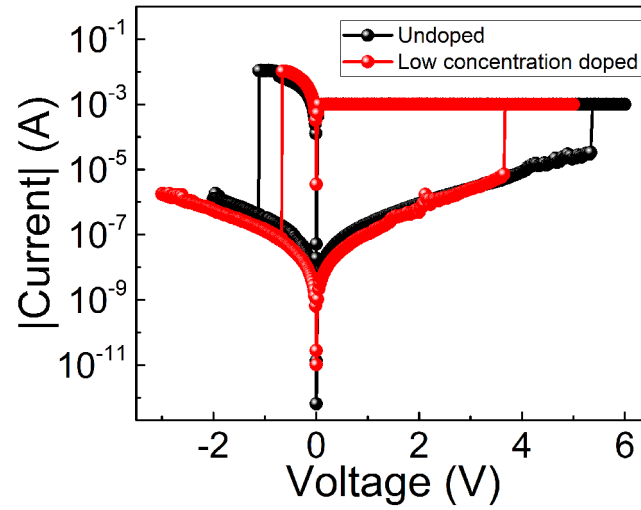


Figure S6. Typical DC I – V curves of Pt/undoped TaO_x/Pt and Pt/TaO_x:Ag (low concentration)/TaO_x/Pt memory devices. The RS cycles including unexpected SET processes possess larger threshold voltages, higher RESET currents and worse operation endurance.

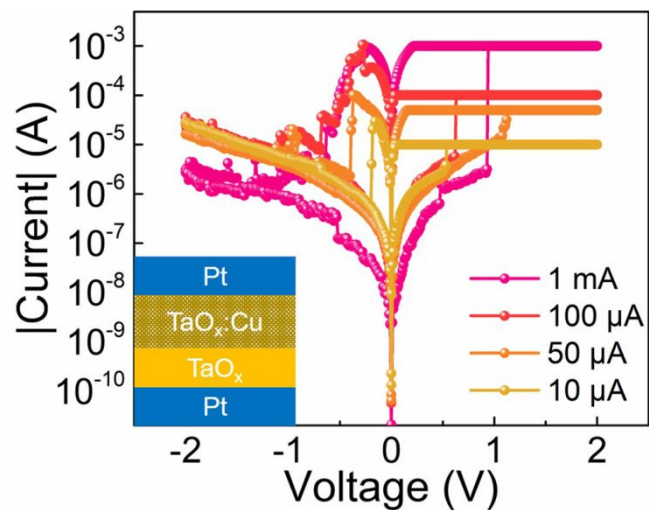


Figure S7. Typical DC I – V characteristics of the Pt/TaO_x:Cu/TaO_x/Pt memory device under different I_{CC} of 1 mA, 100 μ A, 50 μ A and 10 μ A. The inset shows the schematic of the Pt/TaO_x:Cu/TaO_x/Pt memory device.