Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Bipolar resistive switching with negative differential resistance effect in $Cu/BaTiO_3/Ag$ device

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S1. *I-V* curves fitting for calculation of nonlinearity factor and Schottky barrier height in the Cu/$BaTiO_3$/Ag device

Since the *I-V* curves both for LRS and HRS show nonlinear characteristics, the nonlinearity factor can be calculated by fitting the *I-V* curves.[1-3] The data of Fig. 2(a) is used to fit the *I-V* nonlinear characteristics. Fig. S1(a) shows the experimental and fitted *I-V* curve of LRS in semi-log scale with the applied voltage varied from 0.1 V to 4.0 V. Almost linear fitting can be obtained and the slope of the fitted straight line (blue) is about 1.1. The inset shows the symmetrical *I-V* curves and the arrows indicate the voltage sweeping directions. Similar fitted results can be also obtained with negatively biased voltages (-4.0 V ~ -0.1 V). Therefore, Ohmic conduction mechanism is mainly responsible for LRS. Fig. S1(b) shows the experimental and fitted *I-V* curve of HRS with the applied voltage varied from 0.3 V to 3.0 V. It is found that the *I-V* curve can be well fitted by the Schottky equation [4-6]

$$I = SA^*T^2 exp\left[\frac{\Phi - \left(e^2/4\pi\varepsilon_0 d\varepsilon_r\right)^{1/2} V^{1/2}}{kT}\right], \quad (1)$$

where S is the diode area, A^* is the Richardson constant, T is the temperature (which is set at 300 K), Φ is the barrier potential arising from the different work functions between the metal electrodes and oxide insulator, e is the electronic charge, e_0 is the permittivity of free space, d is the film thickness, ε_0 is the optical dielectric constant, V is the applied voltage, and k is the Boltzmann constant. It is noted that the fitting calculation needs to be performed under the assumption of $A^*= 1.0\times10^{-6}$ $Am^{-2}K^{-2}$ and $T = 300$ K. Therefore, the Schottky barrier conduction mechanism is mainly responsible for HRS. In addition, the Schottky barrier height arising from the Cu-$BaTiO_3$ interface is calculated to be 0.582 eV. Similar fitting procedure can be applied to other *I-V* curves.

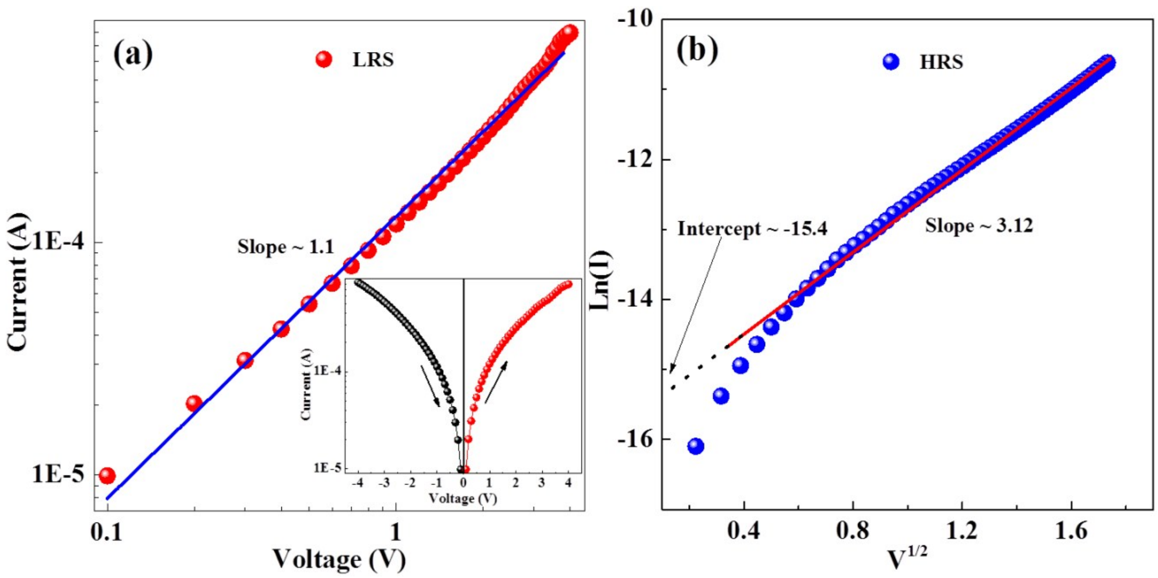

Fig. S1. The experimental (dotted) and fitted (lined) *I-V* curves for LRS (a) and HRS (b). The inset of (a) shows the symmetrical *I-V* curves for LRS and the arrows therein indicate the sweeping directions of the applied voltage.

References

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