BARIUM TITANATE PEROVSKITE BIPOLAR RESISTIVE MEMORYWITH AN ULTRA-HIGH RESISTIVE WINDOW OF 10^6

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Abstract - This study demonstrates an inorganic perovskite barium titanate ($BaTiO_x$) resistive memory with a high OFF/ON resistance ratio of 10^6. The $BaTiO_x$ resistive switching layer was deposited on a n^+-Si substrate using a radio-frequency sputtering process under flowingAr and O_2 gases with flow rates of 3 and 6 sccm. After that, Ag top electrodes were deposited using anevaporator. Current-voltage characteristics, as revealed in Fig. 1, show thatthe Ag/$BaTiO_x$/n^+-Si device can switch from a high-resistance state(OFF state) to a low-resistance state (ON state) at around 4 V when the voltage applied to the Ag top electrode sweeps from 0 to 5 V andit can reset from the ON state to theOFF state when the applied voltage sweeps to the negative region. The reset voltage is ~–3 V andthe OFF/ON resistance ratio is 10^6.

Data retention test indicates that the OFF and ON-state resistances have no significant degradation for over 8×10^3 s, as shown in Fig. 2. The device lifespan estimated by an extrapolation method is over 10 years. Furthermore, the device can repeatedly set and reset over 300 times. The resistive switching behavior of the Ag/$BaTiO_x$/n^+-Si device is caused by the formation and rupture of Ag conductive filaments in the $BaTiO_x$ resistive switching layer.When applying a voltage to the Ag electrode, Ag ions driftinto the $BaTiO_x$ layer and form Ag conductive filaments.The device switches from an OFF to an ON state. As a negative bias is applied to the Ag electrode, the Ag ions in the conductive filaments are attracted back to the electrode, resulting in rupture of Ag conductive filaments. The device switchesback from ON to OFF state.Electrical characteristics of the device measured under different voltage cycles and temperature dependence of the ON-state resistance are investigated to confirm the validity of the proposed resistive switching mechanism.We also found thatthe stoichiometry of the $BaTiO_x$resistive switching layercan be controlled by modifying the oxygen flow rate during the sputtering process, which can lead to an improved device stability.The proposed $BaTiO_x$ resistive memory shows great potential for future high-performance and high-density storage applications.

Keywords - Perovskite, Barium Titanate ($BaTiO_X$), Bipolar, Resistive Switching, Resistive Random-Access Memory (RRAM)

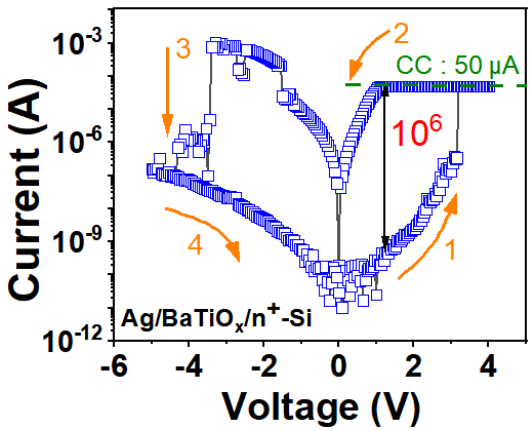


Fig. 1 Resistive switching characteristics of Ag/$BaTiO_X$/n^+-Si bipolar memory.

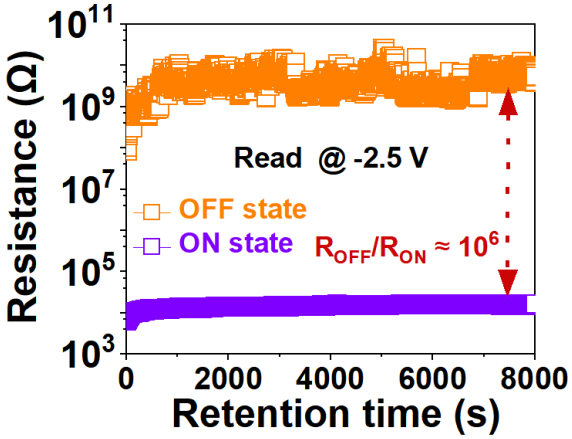


Fig. 2 Data retention capability of Ag/$BaTiO_X$/n^+-Si bipolar memory.

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