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What can we learn from AC impedance study about the bipolar resistive switching effect in $LaAlO_3$/Nb:$SrTiO_3$ heterostructures XINGLI JIANG, YONGGANG ZHAO, XIN ZHANG, MEIHONG ZHU, HUIYUN ZHANG, Department of Physics and State Key Laboratory of Low-Dimensional Quantum Physics, Tsinghua University,, DASHAN SHANG, JIRONG SUN, Beijing National Laboratory for Condensed Matter Physics, Chinese Academy of Sciences — Recently, resistive switching (RS) effect has attracted much attention due to its importance in potential applications in resistance random access memory. It has been shown that traps play an important role in RS effect. However, a direct and in-depth study on the characteristics of traps is still lacking so far, including the spatial and energy distribution of traps, relaxation of trapped carriers and transport of carriers via traps, especially the effect of historical process on the transport of carriers, which are important for understanding the mechanism of RS effect and also essential for optimizing devices. We studied the RS effect in heterostructures composed of $LaAlO_3$ (LAO) and Nb:$SrTiO_3$ (NSTO) from 80 to 300 K by using AC impedance technique. It was demonstrated that the bipolar RS effect originates from the LAO/NSTO interface and the resistance states are controlled by the filling status of traps via the trapping/detrapping of electrons. Moreover, the spatial and energy distributions of traps and the effect of history on the transport of carriers were obtained. A model was proposed to explain the experimental results. This work demonstrates that AC impedance technique is powerful for uncovering the mechanism of RS effect.

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