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Joule Self-Heating Effects and Controlling Oxygen Vacancy in $La_{0.8}Ba_{0.2}MnO_3$ Ultrathin Films with Nano-Sized Labyrinth Morphology

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Abstract : The electric current induced Joule heating effects have been investigated in $La_{0.8}Ba_{0.2}MnO_3$ ultrathin films deposited on $LaAlO_3$(001) single crystal substrate with smaller lattice constant by using the sol-gel method. By applying moderate bias currents (~ 10 mA), it is found that Joule self-heating simply gives rise to a temperature deviation between the thermostat and the test sample, but the intrinsic ρ(T) relationship measured at a low current (0.1 mA) changes little. However, it is noteworthy that the low-temperature transport behavior degrades from metallic to insulating state after applying higher bias currents (> 31 mA) in a vacuum. Furthermore, metallic transport can be recovered by placing the degraded film in air. The results clearly suggest that the oxygen vacancy in the $La_{0.8}Ba_{0.2}MnO_3$ films is controllable in different atmospheres, particularly with the aid of the Joule self-heating. According to the SEM images, we attribute the controlled oxygen vacancy to the nano-sized labyrinth pattern of the films, where the large surface-to-volume ratio plays a curial role.

Keywords : controlling oxygen vacancy, joule self-heating, manganite, sol-gel method
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