FABRICATION OF SNO_X RESISTIVE RANDOM ACCESS MEMORIES BY USING A SOLUTION PROCESS

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Abstract- Resistive random access memories (ReRAMs) have attracted much attention as future nonvolatile memories due to their advantages of low power consumption, high switching speed, and high density integration [1]. RRAMs by using solution processed SnO_x thin films as the resistive switching layers were studied in this work. The SnO_x precursor solution was prepared by dissolving 0.2 g tin(II) chloride dihydrate [$Cl_2Sn_2.H_2O$, 98% purity, Alfa Aesar] into 8 ml ethanol and subsequently stirred at 85 □ for 24 h to obtain a transparent solution. The 240-nm-thick ITO was deposited on the glass substrate as the bottom electrode. The first SnO_x film was spin coated onto the ITO/glass substrate at an initial speed of 1500 rpm for 10 s and a final speed of 3000 rpm for 30 s. The deposited SnO_x film was then dried on a hot plate at 90 □ for 1 min. The second and third SnO_x films were stacked by using the same procedure, followed by a curing process at 120 □ for 10 min. The top electrode was fabricated by applying silver paste to the SnO_x surface to obtain the Ag/SnO_x/ITO RRAMs. Resistive switching behavior can be obtained at a bias loop of 0 V →5 V→0 V →-5 V →0 V. The resistance window is ~1000. This value is nearly 20 times larger than 55 of an Al/SnO_x/Pt RRAM, which used a sputtered SnO_x thin film as a resistive switching layer [2]. In addition, the maximum process temperature in this work is 120 □, which is significantly lower than 300 □ in the literature [2]. The high-performance SnO_x RRAM fabricated by a simplified, low-cost and low-temperature process was demonstrated in this paper. The conduction current in the low resistance state (LRS) was found to be dominated by Ohmic conduction. When the RRAM switched to the high resistance state (HRS), space charge limited conduction can explain the carrier transport. The mechanism for the switching from HRS to LRS was explained by oxygen ion migration. The surface morphology and thickness of the SnO_x layer were examined by a scanning electron microscopy and an atomic force microscopy. The carrier concentration and mobility were investigated by Hall measurement while the SnO_x composition was studied by an energy-dispersive X-ray spectroscopy and an X-ray photoelectron spectroscopy. Besides, the transmittance and energy bandgap were also measured by a UV-visible spectroscopy. The proposed mechanisms were supported by above-mentioned analyses. The measurement results are self-consistent and their mutual correlations were studied.

Keywords- Oxide semiconductors, Memories, Solution process, Electrical characteristic

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