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The influence of oxygen-content on the synaptic behavior of InGaZnO memristors for neuromorphic applications

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The memristors have recently attracted much attention due to their potential usefulness for the energy-efficient neuromorphic computing systems [1]. Especially, the synaptic behavior of InGaZnO (IGZO)-based memristors has successfully demonstrated along with many advantages, such as a good uniformity for large area, room temperature process, and ability to control electrical characteristics by changing the oxygen-content [2]. In most oxide memristors including IGZO, either the Schottky barrier height (SBH) modulation or the conductive filament (CF) formation/annihilation resulting from the oxygen vacancy (Vo^{2+}) is believed as operation mechanism [3-4]. In this work, the influence of oxygen-content on the synaptic behavior of IGZO memristors is investigated, herein the oxygen-content in IGZO film is controlled by modulating the oxygen flow rate (OFR) during the RF sputtering as shown in Fig. 1(a). Compared with the higher OFR case, in the case of lower OFR (lower oxygen-content), the initial current level is higher [Fig. 1(b)] due to lower SBH which dominates the thermionic emission transport [Fig. 1(c)]. It is also found that as the OFR becomes lower, the SBH decreases more sensitively under consecutive SET operations [Fig. 1(d)] which is followed by the synaptic behavior with a stronger/weaker potentiation/depression in the case of low-OFR devices [Fig. 1(e)]. Our results suggest that the electrical characteristic and synaptic behavior of IGZO memristors are determined mainly by the SBH modulation in the interface between electrode and IGZO film, which is efficiently controllable by changing the oxygen-content in IGZO film.

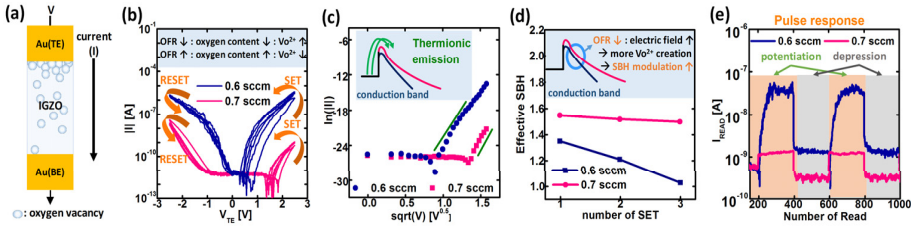

Fig 1. (a) Schematic of the fabricated IGZO memristor. The OFR-dependences of (b) the cyclic I-V sweep, (c) DC ln|I|-$V^{0.5}$ curve, (d) the variation of effective SBH during consecutive SET operation, and (e) synaptic behavior.

References

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