[WI3-K-5]

Analysis of LRS retention fail based on Joule heating effect in InGaZnO RRAM

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The resistance switching effects of metal oxide have been recently investigated for applications as digital swithces of due to their low power consumption, simple structure, and high speed [1]. Many metal oxide materials have been reported to have resistive switching characteristics, especially, InGaZnO (IGZO)-based resistive random access memory (RRAM) has successfully demonstrated along with many advantages, such as a good uniformity for large area, room temperature process [2-3]. However, the modelling study on retention characteristics of RRAM has been rarely investigated. So, in this work, the fail of retaining "SET" state caused by Joule heating to IGZO RRAM which has bipolar resistive switching characteristic like Fig. 1(b) is investigated. Joule heating occurs and causes the fail of retaining "SET" state, even though the polarity of voltage is same as that of "SET" bias like Fig. 1(a). To observe this fail, we simply apply DC bias to IGZO RRAM which state is "SET" and the results of DC bias measurement is shown as Fig. 1(c). It is found that there is the threshold of power (P_{th}) which can cause Joule heating (our model results : P_{th} of IGZO RRAM ≈ 7.5 mW ~ 9 mW like inset of Fig. 1(c)) and also when the power is over P_{th}, the oxygen vacancy diffusion caused by the energy of Joule heating is stronger than the formation of oxygen vacancy, finally undesirable reset occurs. That is similiar with the reset mechanism of unipolar resistive switching device [4]. Our results suggest that Joule heating effect of RRAM can cause undesirable fail of retaining "SET" state and also the analysis of this phenomenon seems to be useful for analyzing and modelling the retention characteristics of RRAM devices.

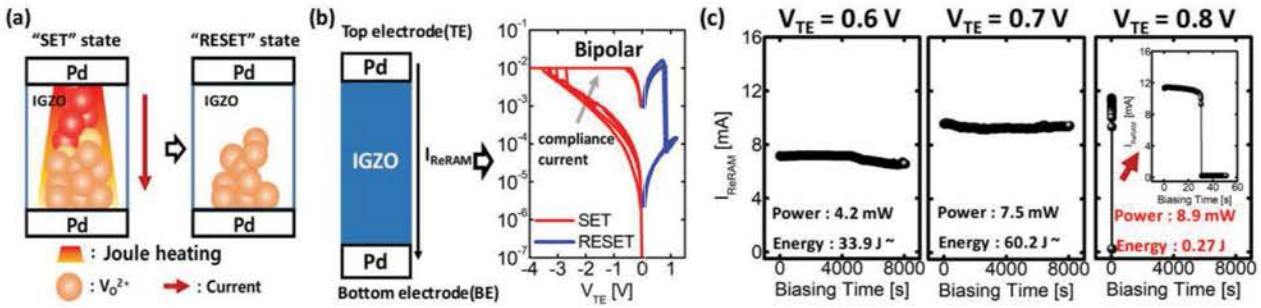

Fig 1. (a) Fail mechanism of retaining "SET" state on IGZO RRAM, (b) structure and electrical characteristics of IGZO RRAM, (c) amplitude of voltage dependent-results of DC bias measurements.

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