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Study of Silicon Nitride Based Conductive Bridge Resistive Switching Memory

Department of Electronics Engineering and Institute of Electronics, National Chiao Tung University

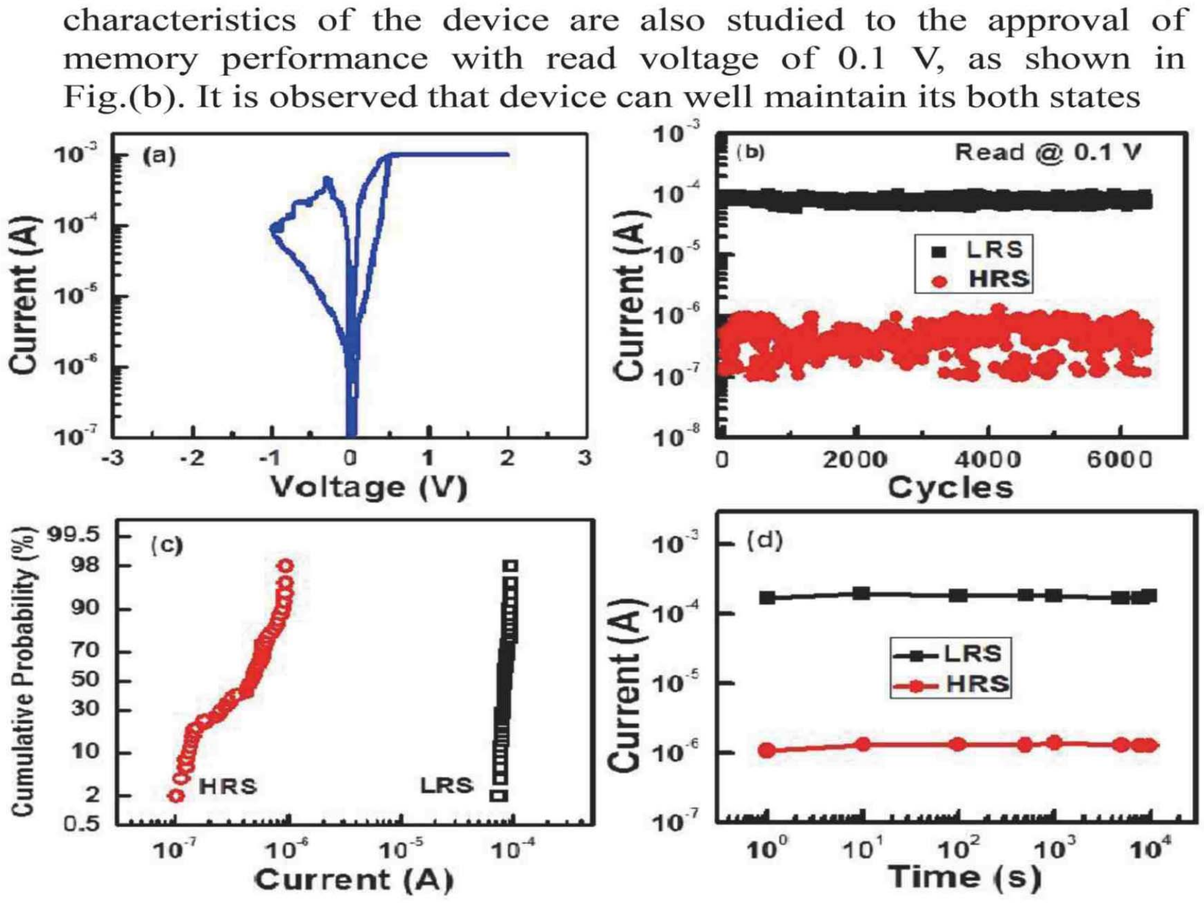
Ph.D. (3rd year): Dayanand Kumar, Advisor: Prof. Tseung-Yuen Tseng

Abstract

Resistive random access memory (RRAM) is the superior candidate for nonvolatile memory application because of fast switching speed, robust scaling ability and excellent capability of CMOS process. Recently, conductive bridge RAM has become promising candidate for conventional charge storage memory due to its low operating power. In my work, the bipolar resistive switching characteristics of $Cu/Al_2O_3/Cu/SiN/TiN$ tri-layer CBRAM device is investigated. The device exhibits good memory performance, such as stable DC endurance up to 6400 cycles, good on/off ratio and room temperature reasonable data retention.

Research Results

Fig.(a) exposes the typical bipolar resistive switching (BRS) behavior in the $Cu/Al_2O_3/Cu/SiN/TiN$ structure. An abrupt current increase occurs when the voltage is swept to 2 V, with 1 mA current compliance (CC) and the device is switched from high resistance state (HRS) to low resistance state (LRS). When the voltage is swept to −1 V without any CC, and the current rudely drops. This means that the device is switched from LRS to HRS. The reliability characteristics of the device are also studied to the approval of memory performance with read voltage of 0.1 V, as shown in Fig.(b). It is observed that device can well maintain its both states for more than 6400 cycles without any degradation. The cycle to cycle variation of the CBRAM device with the Ta buffer layer during continuous 100 DC switching cycles is measured and the effect is shown in Fig.(c). The resistances in two states detected by a 0.1 V read voltage, indicates that both HRS and LRS show wide distribution in the device. This wide resistance distribution and high LRS/HRS ratio in the device is recognized due to the control of Cu ion in the resistive switching layer. The large variation of LRS and HRS in the device suggests that the formation and rupture of the conductive filament happen randomly in the resistive switching layer due to the migration of the Cu ion. Fig.(d) confirms the non-volatility of data storage competence of the device by the retention test. The resistance values in both states are stable with the high LRS/HRS ratio of around 10^2 in magnitude, and no substantial degradation is observed for more than 10^4 s.



Research Experience

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