Characterization of γ-Fe_2O_3 memristors via physics-based empirical I-V model

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Recently, memristor has been studied as one of the most promising candidates for next generation nonvolatile-memory due to its fast write/read speed, superior scalability, compatibility with CMOS technology and multi-bit storage potential [1]. We here represent the empirical current-voltage (*I-V*) model to explain the Pt/γ-Fe_2O_3/Pt (Fig. 1 (a)) memeristive switching behaviors based on the variation of the state variables. Noticeably, physical mechanisms such as tunneling [2] and back-to-back Schottky characteristics are taken into account (Fig. 1(b)). In addition, we show that the proposed empirical *I-V* model can be successfully incorporated into the SPICE model using Verilog-A (Fig. 1(c)). Our model has a distinguished merit in perspective of the opimization of material, process, and memeristive device in that it is able to be identified by the resistance variation of ON state in the formula and without any fitting parameter in the OFF state. This study would be helpful in understanding of the memristive behaviors and also give insight into the design for innovative memristor-based circuit applications.

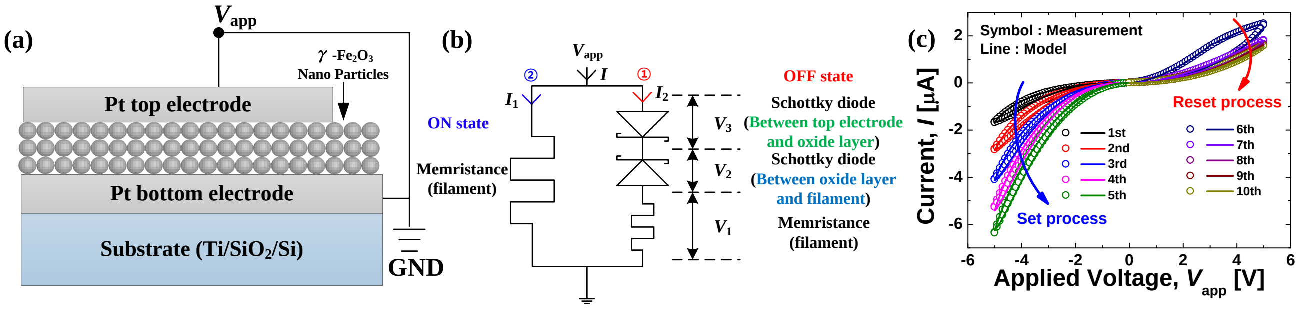

Fig 1. (a) Schematic of the Pt/γ-Fe_2O_3/Pt memristor, (b) equivalent circuit of the memristor, and (c) comparison of empirical *I-V* model on the measured *I-V* characteristics.

[1] Y. S. Chen, H. Y. Lee, P. S. Chen, C. H. Tsai, P. Y. Gu, T. Y. Wu, K. H. Tsai, S. S. Sheu, W. P. Lin, C. H. Lin, P. F. Chiu, W. S. Chen, F. T. Chen, C. Lien, and M.-J. Tsai, *in IEDM Tech. Dig.*, pp. 31.3.1-31.7.4, 2011.

[2] K. Eshraghian, O. Kavehei, K. R. Cho, J. M. Chappell, A. Iqbal, S. F. Al-Sarawi, and D. Abbott, *proc. IEEE*, vol. 100, no. 6, pp. 1991-2007, Jun. 2012.