Contact resistance change memory with N-doped $Cr_2Ge_2Te_6$ phase change material

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Phase change materials (PCMs), based on rapid and reversible electrical property changes between amorphous and crystalline phases, have been attracting much attention for their promising application to non-volatile memories such as phase change random access memory (PCRAM). In recent years, many researchers are devoting to explore various PCMs for the control of phase change temperature, faster phase change speed and larger electrical contrast. Typical PCMs, such as $Ge_2Sb_2Te_5$ (GST) (Figure 1a), show a large resistivity contrast of approximately five orders of magnitude. While in general, the electrical contrast between the two phases in practical PCRAM cells is less than two orders of magnitude, suggesting the importance of the contact resistance between PCM and electrode. (Figure 1b) By continuously scaling down the device size, the interfacial effects between the PCM and the metal electrode will play an important role in determining the total device resistance. Hence, the investigation of the contact between PCM and metal electrode is of more practical significance. Chua et al. [1] suggested that controlling low specific contact resistivity will reduce the power dissipation at the interface and promote higher switching proficiency; Hwang et al. [2] demonstrated that RESET current can be effectively reduced by high contact resistance. Shindo et al. [3] proposed a larger contact resistance contrast is desirable for better accuracy of reading operation. In this work, we proposed an non bulk resistance based PCRAM with the switching property only modulated by the contact between PCM and electrode. The functional PCMs exploited here is N-doped $Cr_2Ge_2Te_6$ (NCrGT), showing almost no resistance difference between two phases. (Figure 1a) Typical switching behavior revealing a three-order on/off on account of large contact resistance contrast has been demonstrated, with a lower Set and Reset voltage than typical PCM GST. (Figure 1b) The conduction mechanism has also been investigated by IV measurement of the electrical property of interface between NCrGT and W electrode.

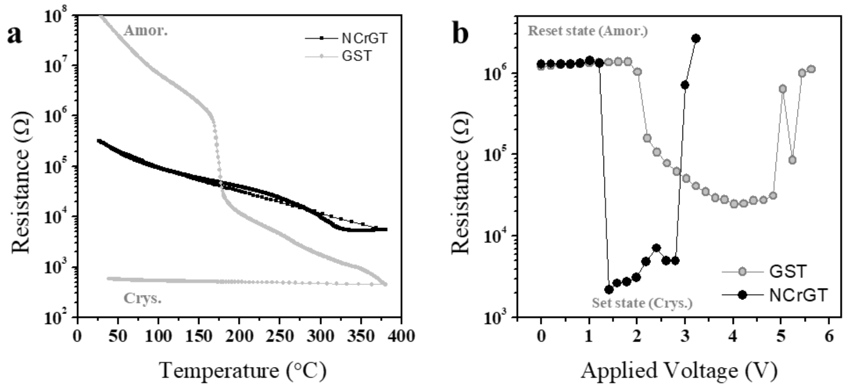

Figure 1. a. Resistance of GST and NCrGT films as a function of temperature. b. R-V characteristics of GST and NCrGT memory cells.

[1] E.K. Chua, et al. Applied Physics Letters **101**, (2012).

[2] I. Hwang, et al. Applied Physics Letters **106**, 32 (2015).

[3] S. Shindo, et al. Materials Science in Semiconductor Processing **47**, 1 (2016).