Low Power Consumption in Superlattice-Like NiOx/GeSb Multilayer Film for Phase Change Memory Application

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As computing technologies such as big data, artificial intelligence and machine learning develops, the development of memory device that stores and processes vast amounts of data is also required. From various performance of memory device, phase change memory (PCM) is the powerful candidate for next-generation memory. $Ge_2Sb_2Te_5$ (GST-225) based PCM has outstanding performance such as non-volatility, long write endurance and high inherent scalability with existing complementary metal-oxide-semiconductor process. Despite its advantages, the GST-225 based PCM is hindered by reliability such as low switching speed, low crystalline temperature, and resistance drift.

In this study, we propose GeSb-based phase change memory device that can obtain a fast switching speed, owing to the fragile Sb-Sb bond while excluding Te atoms that degrade repeatability of memory operations due to high vapor pressure and low melt point. In addition, we insert the NiOx layers on the GeSb layer to generate the thermal boundary resistance (TBR) at the interface of the GeSb layer and the NiOx layer. The superlattice-like NiOx/GeSb multilayer film has the higher crystallization temperature than the single layer of GeSb and suppresses heat dissipation by TBR to efficiently utilize the heat required for phase change in GeSb layer. The adding of NiOx can improve the stability of GeSb material and lower power consumption phase change memory devices. Fig. 1 (a-b) shows the results of the I-V sweep from PCM devices with different structures. The threshold voltage of the NiOx/GeSb superlattice PCM device is 1.6 V, which shows significantly lower power than the GeSb-based PCM device (~ 3.4 V). Consequently, NiOx/GeSb multilayer might show low power consumption behavior on pulse operations and thermal stability by inserting NiOx layers.

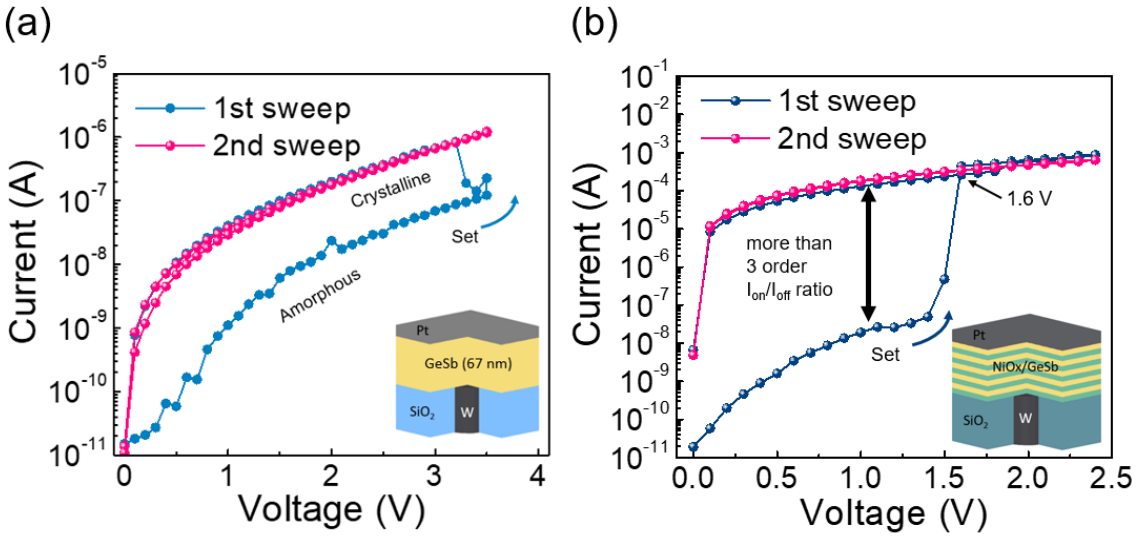

Figure 1. I-V sweep results of (a) GeSb-based PCM device and (b) [NiOx (5 nm)/GeSb (7 nm)] superlattice-like structure PCM device.