Molecular weight dependence of polymer active layer on electrochemical metallization memory

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Recently, the electrochemical metallization (ECM) memory has been extensively studied for a new class of non-volatile memory devices owing to its simple architecture and outstanding performance [1, 2]. Particularly, the ECM memory devices based on the polymer active layers allow the mechanical flexibility and low cost [3]. It has been reported that the mobility of the metal cation in an active layer plays a critical role in the resistive switching of the ECM memory [4, 5]. However, the molecular weight (M_w) dependence of the polymer active layer on the ECM memory has not been explored so far although M_w is one of the important material parameters to govern the mobility of the metal cation.

In this work, we investigate how M_w influences the resistive switching of the ECM memory based on a polymer active layer. Two different devices of the ECM memory, based on poly(methyl methacrylate) (PMMA) with M_w = 996,000 g/mol and 120,000 g/mol for the active layers, were fabricated. Silver was thermally evaporated at the rate of 0.5 nm/s in 10^{-6} Torr for the top and the bottom electrodes. From the device characteristics as shown in Fig. 1, the voltages for writing and erasing the memory state of the device were found to decrease with lowering M_w of PMMA, whereas the reliability of the device was improved as M_w of PMMA increased. For the case of the lower M_w, the relatively large amount of total free volume leads to the higher mobility of the metal cation which reduces the forming voltage of active metal filaments and causes the gradual accumulation of metal clusters in the polymer active layer. Our results will provide a useful guideline for tailoring the electrical performance of a flexible ECM memory storage system.

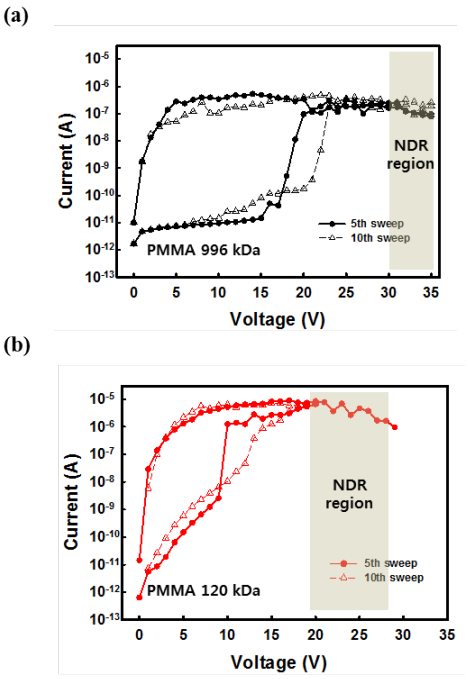

Fig. 1 I-V characteristic of the device with poly(methyl methacrylate) with (a) molecular weight (M_w) of 996,000 g/mol, (b) M_w of 120,000 g/mol

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