Unipolar resistive switching memory using graphene oxide for flexible one diode-one resistor (1D-1R) cell array

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Abstract

Resistive random access memory (RRAM) type flexible memory is attracting increasing attention as a promising candidate for future flexible nonvolatile memory (NVM) due to its good scalability, fast switching speed, and low-power consumption. Recently, the graphene oxide (GO) has been proposed as potential resistive switching material because GO can be readily fabricated using a room temperature spin-coating method and has reliable memory performance in terms of retention and endurance characteristics during bending test. Up to now, most of reported RRAM based on GO exhibited bipolar resistive switching memory (BRS) in which both SET and RESET processes are dependent of voltage polarities. However, unipolar resistive switching memory (URS), in which both SET and RESET processes occur at the same voltage polarities, is essential in RRAM for integration of the switching device with memory, to address the sneaky path problems in cross-bar arrays. To realize the stable URS memory based on GO, we investigated the effect of electrode metals and GO thickness on the Metal/GO/Metal RRAM. The Ni/GO/Au structure with 95-nm-thick GO shows good switching performance with the low set/reset voltages, and excellent endurance cycles, but its on/off current ratio has poor performance. The Al/GO/Au structure with 55-nm-thick GO has a high on/off current ratio, but it has poor endurance and the set/reset voltages are very variable. To improve the unstable memory performances, GO-based RRAM was annealed in the high vacuum condition for making reduced graphene oxide (rGO) which has lower oxygen functional group acted as trap sites at the interface than GO. With Al/rGO/Au structure with 55-nm-thick rGO, we successfully could show the URS behavior with the on/off ratio to over 10^3 which sustains over 100 cycling, and reduce the variation of set/reset voltages. This work provides an important step for developing understanding of the fundamental physics of unipolar resistive switching in GO, for the one diode – one resistor (1D-1R) cell array to future flexible electronics.