Unipolar and bipolar resistive switching of nonstoichiometric TiOₓ thin films

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As one of the resistive random access memory (ReRAM) materials, the effect of post annealing of the TiOₓ thin film was researched.

35-nm-thick TiOₓ thin films were deposited using rf magnetron sputtering system and annealed at various temperature from 0 to 800°C. To make metal-insulator-metal (MIM) structure, Pt was used as the top and bottom electrodes (TE and BE, respectively).

In the composition of the TiOₓ film, nonstoichiometric TiOₓ films regardless of the annealing temperature (x ≈ 1.65) were observed. In case of an as-dep. TiOₓ sample and TiOₓ samples which were annealed up to 300°C, both unipolar resistive switching (URS) and bipolar resistive switching (BRS) were observed. And in case of TiOₓ samples which were annealed at 400°C and 500°C, only BRS was observed regardless of applied voltage level.

It is believed that the increase in the work function of the TiOₓ film after the annealing process brings about the decrease in the potential barrier height, and this change of Schottky barrier height have an effect on the electron transfer process.

Above 600°C, moreover, the resistive switching characteristics was hardly observed and it is thought that the current path besides oxygen vacancies increased because the grain size and roughness of the TiOₓ film abruptly increased due to the crystallization, so the hysteresis depending on the voltage sweep vanished.

Keywords: RRAM, TiO₂, resistive switching