Observation of Resistive Switching on Cu/MoOx ReRAMs using the in-situ TEM method

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Resistance RAM (ReRAM) is a strong candidate for the next-generation memory, because it has a simple structure, fast switching speed and non-volatility. However, the switching mechanism is not yet well known. In order to clarify the mechanism, we introduced in-situ transmission electron microscopy (TEM). Structural changes in nanometer scale were observed simultaneously with the resistive switching.

In this work, MoOx ReRAMs were investigated by the use of in-situ TEM. The MoOx switching layer was sandwiched between Cu and TiN electrodes (Fig. 1). By applying a positive voltage to the Cu electrode, a resistive switching from high resistance state (HRS) to low resistance state (LRS) occurred (Fig. 2, region (a)), and formation of a precipitation was observed near the TiN electrode. (Fig. 3(a)) On the other hand, when a negative voltage was applied, resistive switching from LRS to HRS occurred (Fig. 2, region (b)) and the precipitation disappeared (Fig. 3(b)). This precipitation seems to work as a current path and to contribute resistive switching.

Fig. 1 TEM image before resistive switching. Transition in the square region is shown in Fig. 3.

Fig. 2 I-V characteristics obtained during ReRAM operation.

Fig. 3 TEM image after resistive switching of (a) HRS to LRS and (b) LRS to HRS.