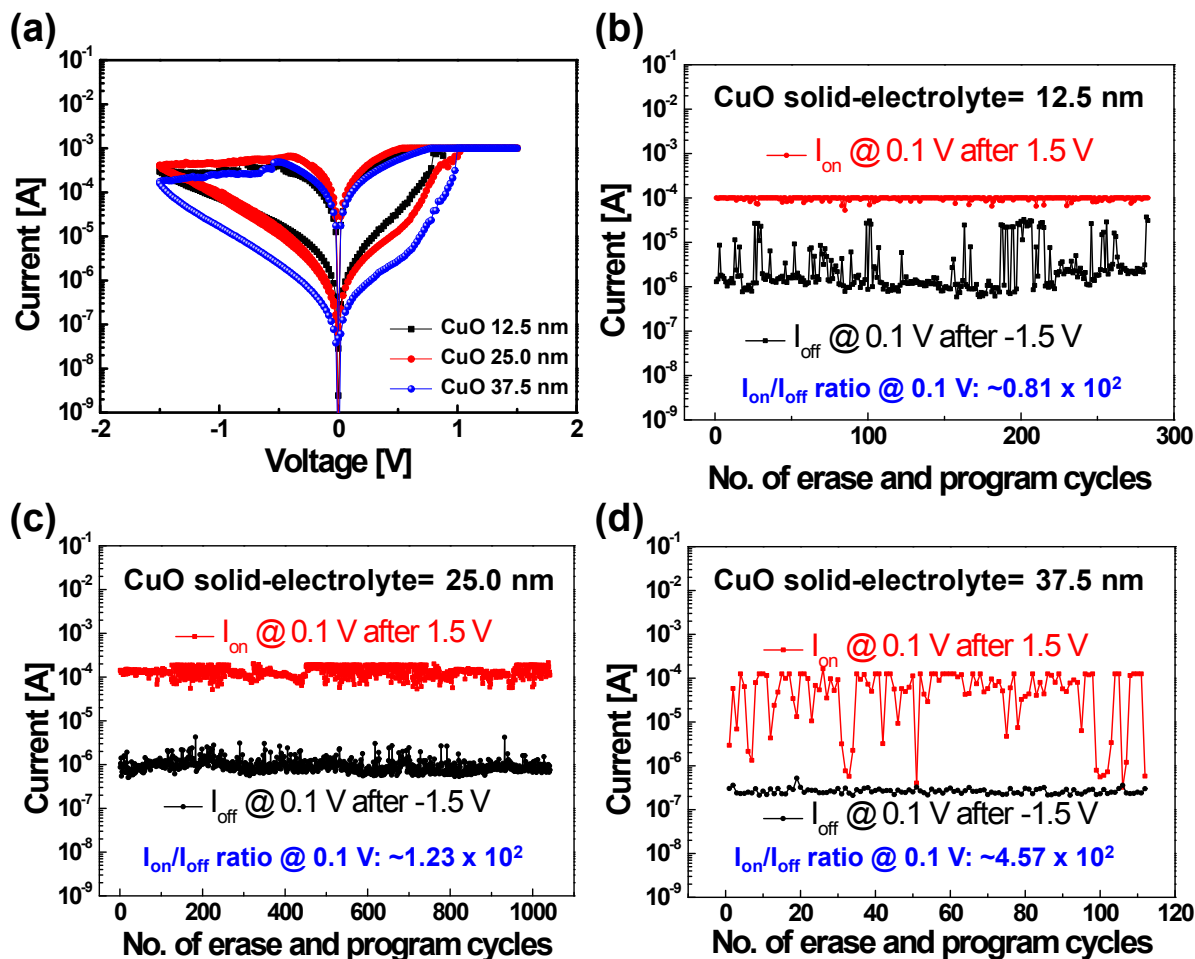


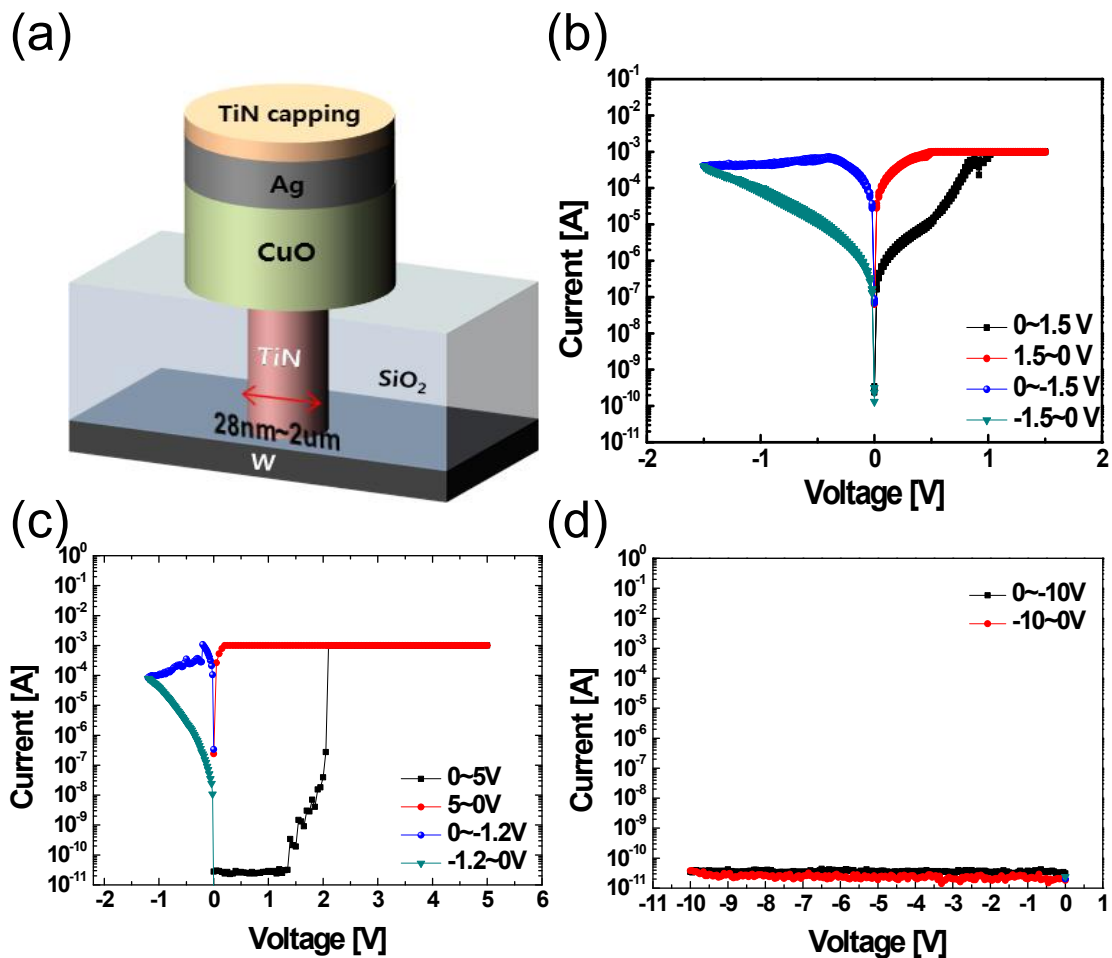
Supporting Information

Supplementary figure 1 (Fig. S1)



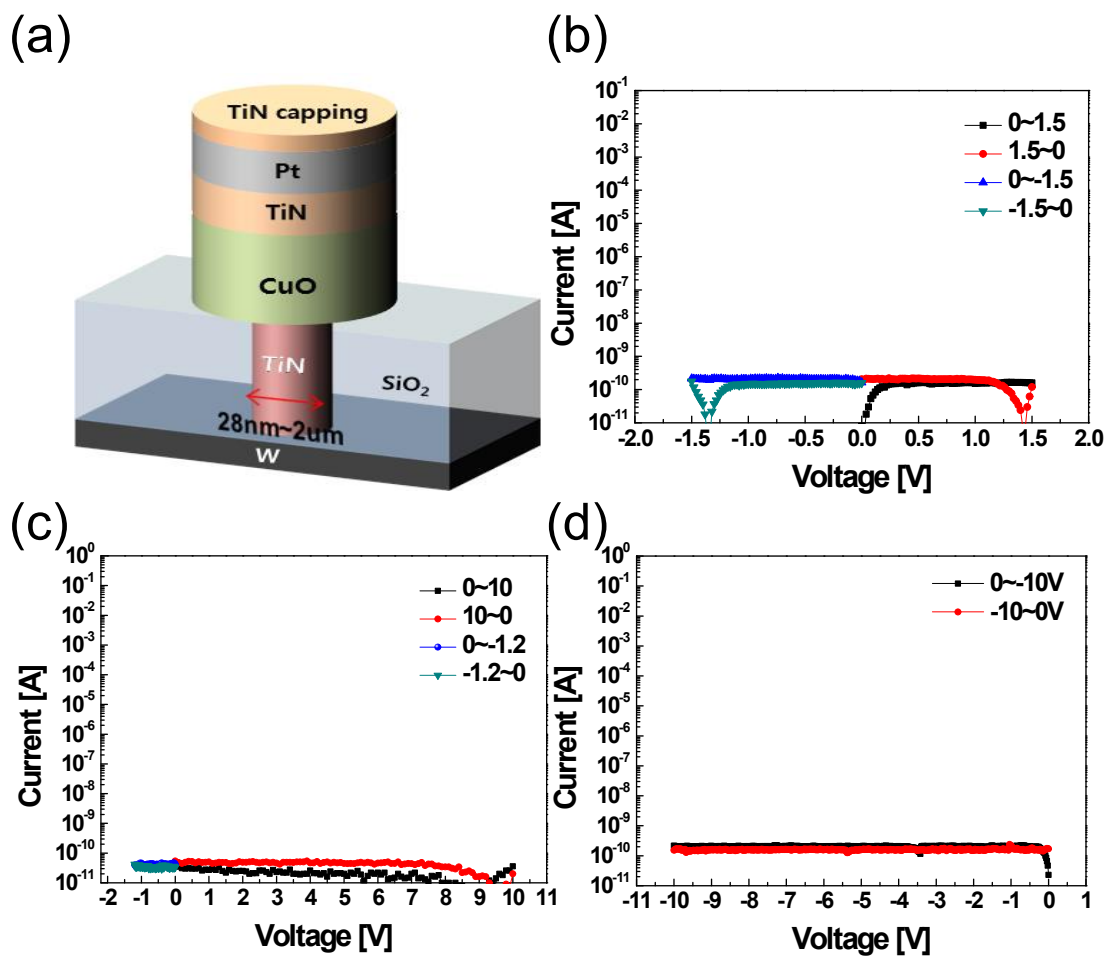
Supplementary figure 1. Non-volatile memory characteristics depending on the CuO solid-electrolyte thickness: (a) dc I - V curves as a function of the CuO solid-electrolyte thickness, (b) dc write/erase endurance cycles at the 13-nm-thick CuO solid-electrolyte, (c) dc write/erase endurance cycles at the 26-nm-thick CuO solid-electrolyte, and (d) dc write/erase endurance cycles at the 39-nm-thick CuO solid-electrolyte

Supplementary figure 2 (Fig. S2)



Supplementary figure 2. CuO solid-electrolyte-based CBRAM cell with Ag top electrode: (a) memory-cell structure, (b) I - V curve after the forming process with the applied positive bias, (c) forming process with the applied positive bias, and (d) forming process with the applied negative bias

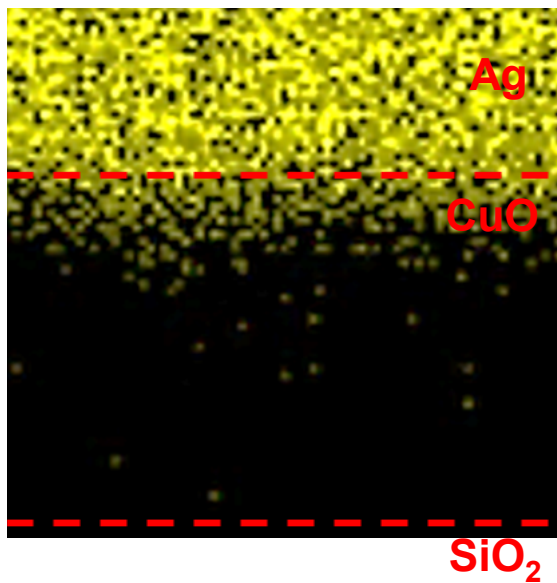
Supplementary figure 3 (Fig. S3)



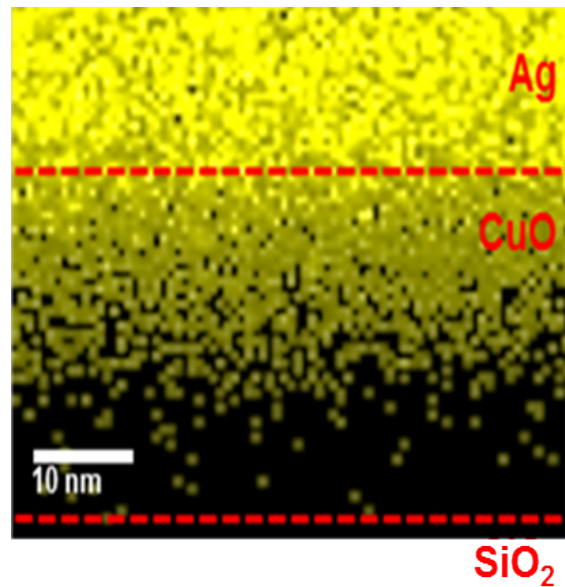
Supplementary figure 3. CuO solid-electrolyte-based CBRAM cell with TiN top electrode: (a) memory-cell structure, (b) I - V curve after the forming process with the applied positive bias, (c) forming process with the applied positive bias, and (d) forming process with the applied negative bias

Supplementary figure 4 (Fig. S4)

(a) ➤ w/o annealing

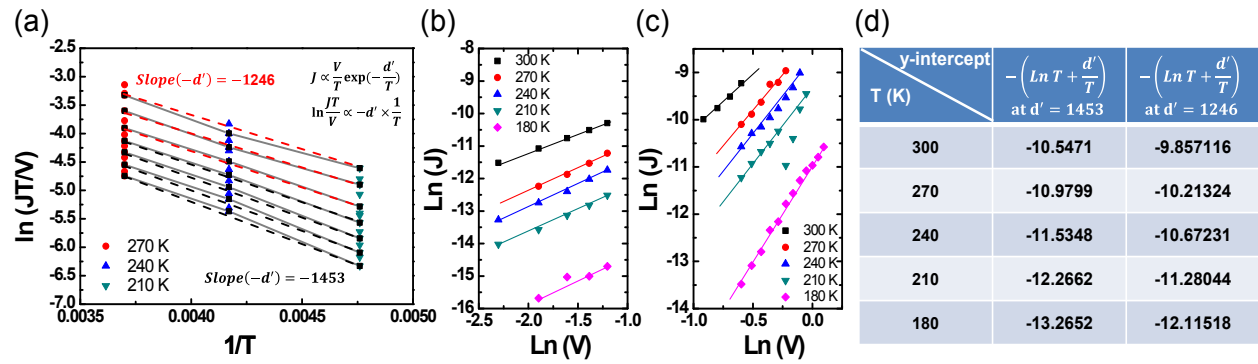


(b) ➤ 500 °C annealing



Supplementary figure 4. Ag ion map for cross-sectional CBRAM analyzed by x-TEM and EDAX: (a) without N₂ annealing and (b) with N₂ annealing at 500°C for 30 min

Supplementary figure 5 (Fig. S5)



Supplementary figure 5. (a) $\ln(JT/V)$ vs. $1/T$ plot for obtaining a constant d' , (b) $\ln(J)$ vs. $\ln(V)$ curve between 0 to ~ 0.48 V, (c) $\ln(J)$ vs. $\ln(V)$ curve between ~ 0.48 to ~ 1.02 V, and (d) a table for y-intercept on temperature at each constant (d').