Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Evolution of pronounced ferroelectricity in $Hf_{0.5}Zr_{0.5}O_2$ thin films scaled down to 3 nm

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Figure S1 shows the characteristics of the polarization and the current density versus the electric field of the MFM capacitors with the HZO thicknesses of ~10, 6, 4.8, 3.6, and 3 nm, respectively, in which the HZO layers were in the pristine state without experiencing any waking-up process. The hysteresis loops and the switching currents of the 10 nm and 6 nm HZO layers are similar to those shown in Figure 2 (measured after the waking-up process), which is consistent with the nearly wake-up free properties as revealed in Figure 12. Multiple peaks of the switching current and antiferroelectric-like hysteresis loops are observed as the thickness of the HZO layer is below 5 nm, suggesting that the t-phase or the pinched domains are present in the pristine HZO layer [1-3].

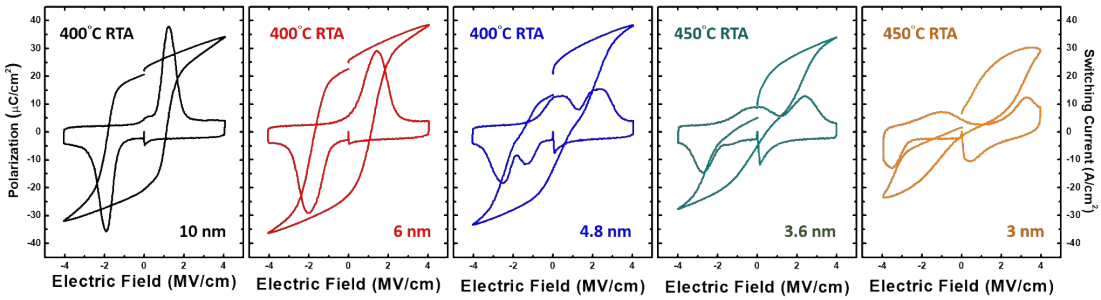

Figure S1. The *P-E* hysteresis loops and the *J-E* curves of the MFM capacitors with different HZO thicknesses from 10 to 3 nm, in which the HZO layers were in the pristine state without experiencing any waking-up process.

Reference:

[1] P. D. Lomenzo *et al.*, "TaN interface properties and electric field cycling effects on ferroelectric Si-doped HfO_2 thin films," *Journal of Applied Physics,* vol. 117, no. 13, p. 134105, 2015.

[2] M. Hoffmann *et al.*, "Stabilizing the ferroelectric phase in doped hafnium oxide," *Journal of Applied Physics,* vol. 118, no. 7, p. 072006, 2015.

[3] T. Schenk *et al.*, "About the deformation of ferroelectric hystereses," *Applied Physics Reviews,* vol. 1, no. 4, p. 041103, 2014.