Supplementary Information

Influence of composition and structure on resistive switching properties of hafnium-titanium-oxide thin films grown by atomic layer deposition

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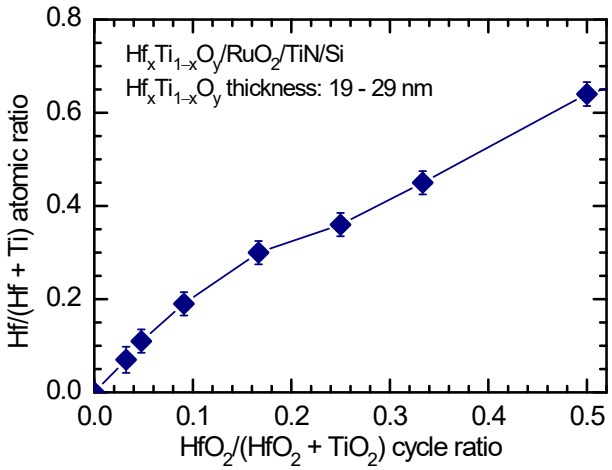

Figure S1. Hf/(Hf + Ti) atomic ratio in HTO films as a function of $HfO_2/(HfO_2 + TiO_2)$ atomic-layer-deposition cycle ratio. The films were deposited at 350 °C on RuO_2/TiN electrodes using $HfCl_4$, $TiCl_4$ and H_2O as the precursors.

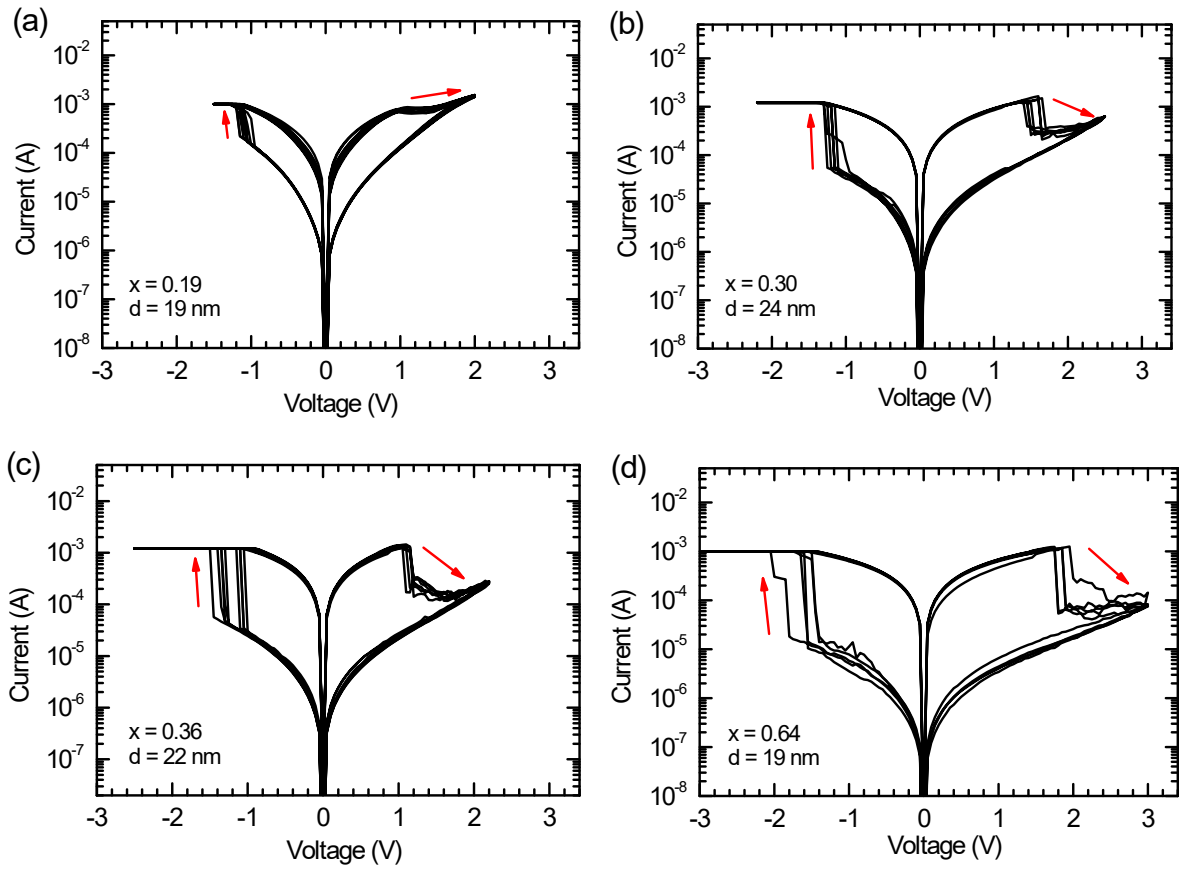

Figure S2. Current-voltage characteristics of Pt/$Hf_xTi_{1-x}O_y$/RuO_2/TiN RS structures with *x* values of (a) 0.19, (b) 0.30, (c) 0.36, and (d) 0.64 in the $Hf_xTi_{1-x}O_y$ layer. The $Hf_xTi_{1-x}O_y$ layer thicknesses are shown in the figure.

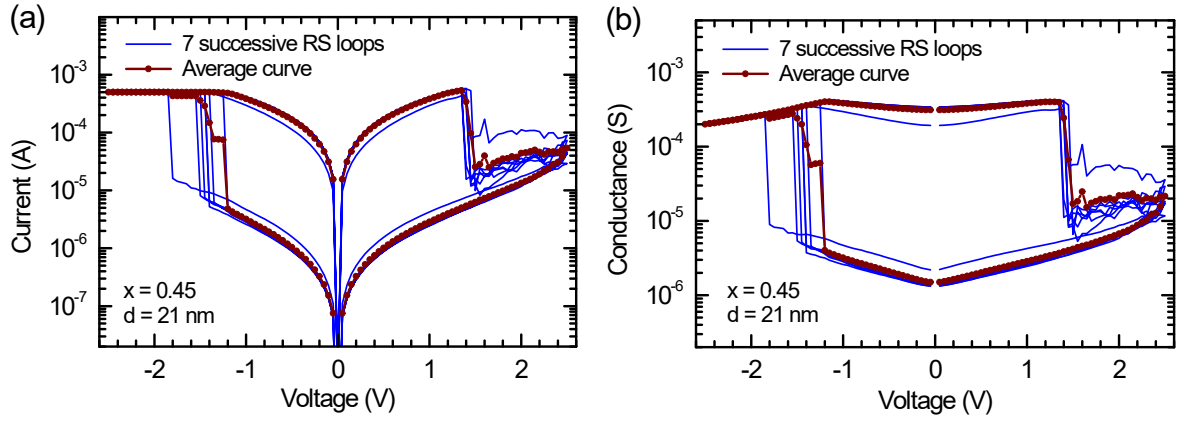

Figure S3. Impact of averaging on the shapes of (a) current-voltage and (b) conductance-voltage characteristics of a Pt/$Hf_xTi_{1-x}O_y$/RuO_2/TiN RS structure with *x* of 0.45 in $Hf_xTi_{1-x}O_y$.

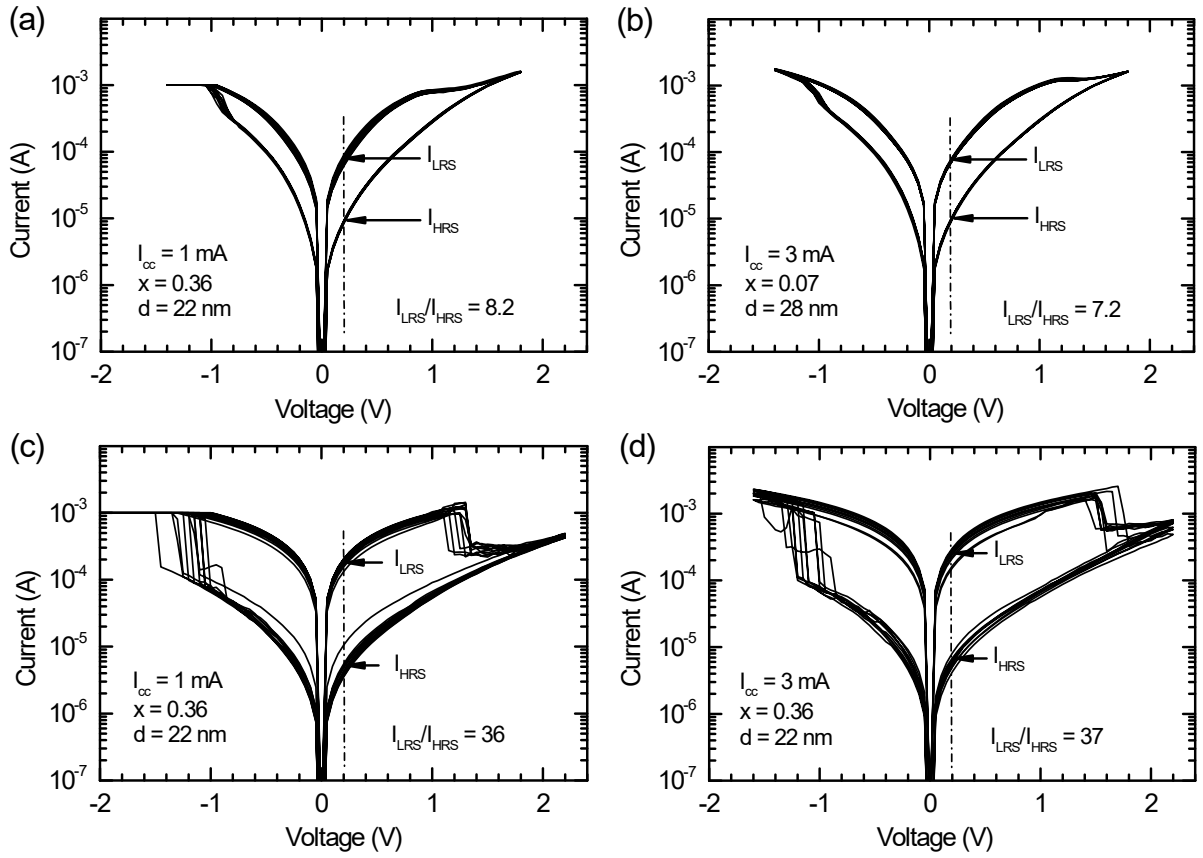

Figure S4. Current-voltage characteristics of $Pt/Hf_xTi_{1-x}O_y/RuO_2/TiN$ RS structures with x values of (a,b) 0.07 and (c,d) 0.36. The characteristics were recorded using compliance current (I_{cc}) of (a,c) 1 mA and (b,d) 3 mA.

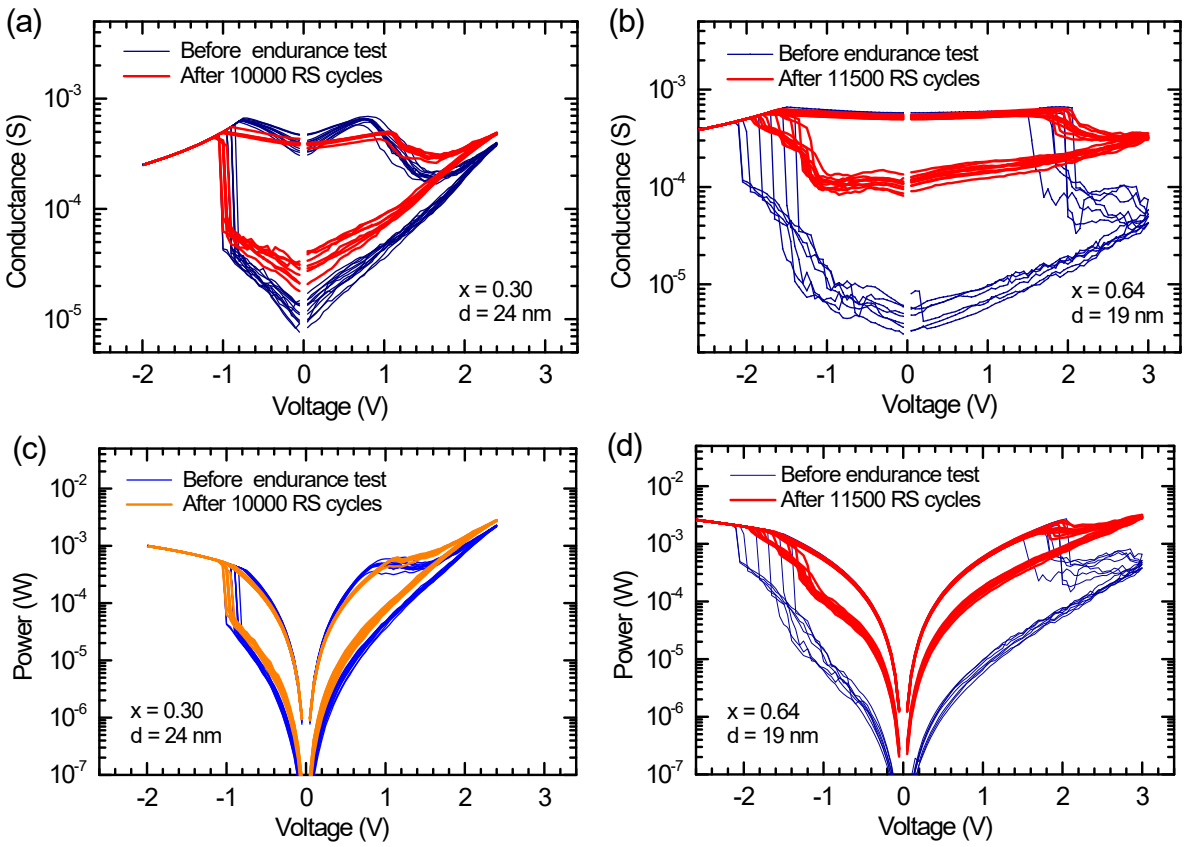

Figure S5. (a,b) Conductance-voltage and (c,d) power-voltage characteristics of Pt/$Hf_xTi_{1-x}O_y$/RuO_2/TiN RS structures with *x* values of (a,c) 0.30 and (b,d) 0.64, recorded before and after endurance tests.

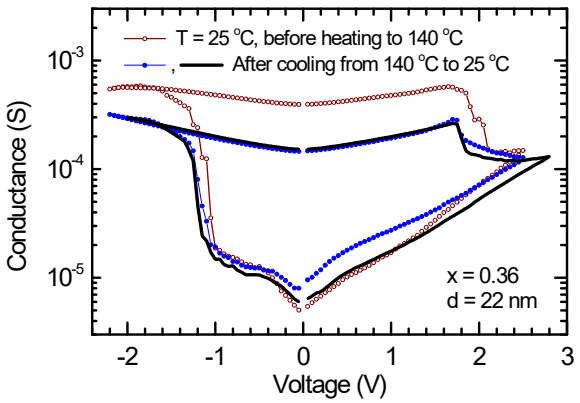

Figure S6. Conductance versus voltage characteristics of a Pt/$Hf_xTi_{1-x}O_y$/RuO_2/TiN RS structure with *x* of 0.36 in the $Hf_xTi_{1-x}O_y$ layer. The characteristics were recorded at 25 °C with voltages ranging from –2.2 to 2.5 V before heating the sample to 140 °C and with voltages ranging from –2.2 to 2.5 V and from –2.2 to 2.8 V after cooling from 140 to 25 °C. The compliance current was kept at –1.2 mA during the measurement of current-voltage characteristics used for calculation of conductance-voltage characteristics.

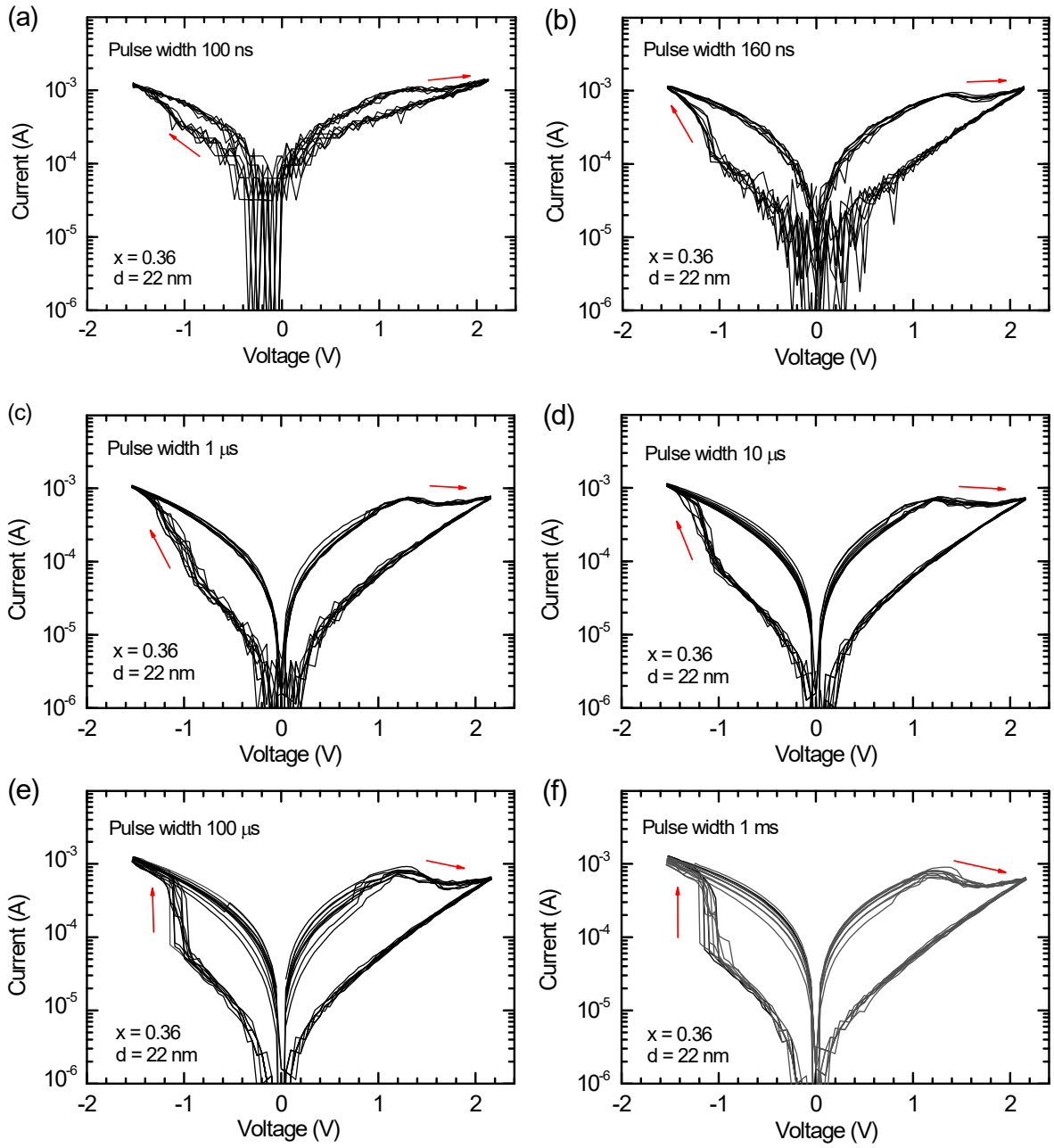

Figure S7. Current-voltage characteristic of a Pt/$Hf_xTi_{1-x}O_y$/RuO_2/TiN RS structure with *x* of 0.36 in the $Hf_xTi_{1-x}O_y$ layer. The characteristics were recorded at room temperature in the pulse mode using pulse durations of (a) 100 ns, (b) 160 ns, (c) 1 μs, (d) 10 μs, (e) 100 μs, and (f) 1 ms.