Supporting Information

A two-terminal binary HfO$_2$ resistance switching random access memory for artificial synaptic device

Xiaozhang Chen,[a,c] You Lv,[a,c] Zhaobo Tian,[a,c] Jingxi Yang,[a] Yuan Zhu,[*a,b] Longxing Su[*a]

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[a] *School of Microelectronics, Southern University of Science and Technology, Shenzhen, 518055, China*

[b] *Engineering Research Center of Integrated Circuits for Next-Generation Communications, Ministry of Education, Southern University of Science and Technology, Shenzhen 518055, China*

[c] *These authors contribute equally to this work.*

[*] *Authors to whom correspondence should be addressed: zhuy3@sustech.edu.cn and sulx@sustech.edu.cn*

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1. Figure S1 The fabrication processes of the HfO$_2$ RRAM device.

2. Figure S2 The Raman spectrum of the as-prepared HfO$_2$ sample.

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8. Figure S8 The SEM images and EDS spectra of the HfO$_2$ MIM device after the measurement.

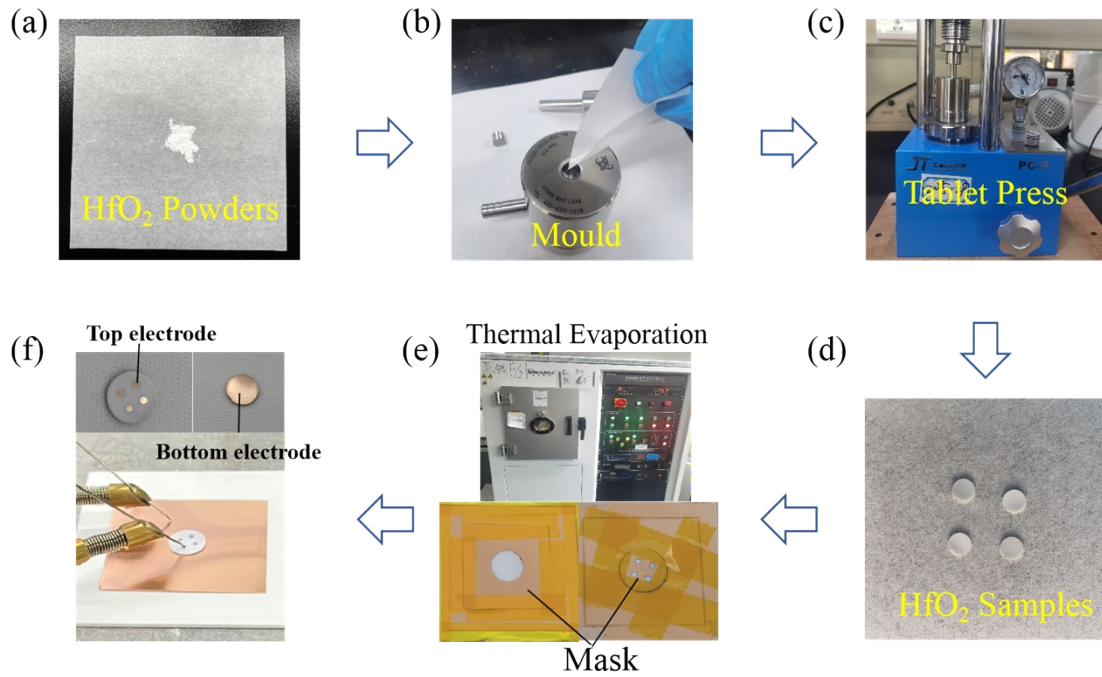**9. Figure S9 The XPS spectra of the HfO$_2$ MIM device after the measurement.**

Figure S1 The fabrication processes of the HfO$_2$ RRAM device.

(a→b) The as-prepared HfO$_2$ powders were loaded into a stainless steel mould; (b→c→d) The as-prepared HfO$_2$ powders were re-shaped into a wafer-liked HfO$_2$ sample under 8 MPa by using a powder tablet press; (d→e→f) The bottom and top Cu electrodes were deposited onto the re-shaped wafer-liked HfO$_2$ sample by using a thermal evaporation method.
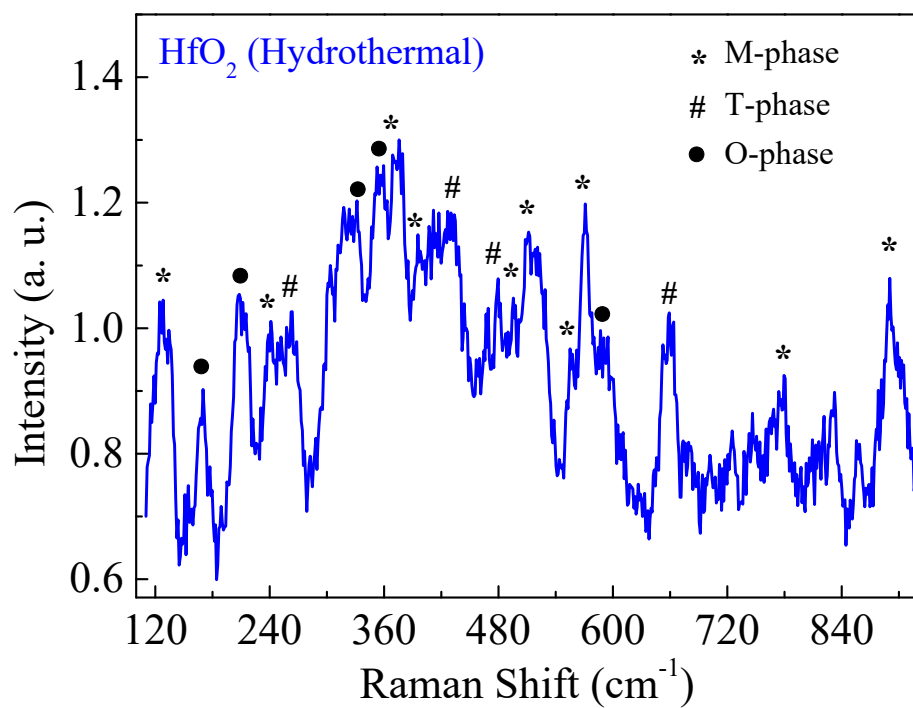
Figure S2 The Raman spectrum of the as-prepared HfO_2 sample.

Figure S3 The solutions mixed with HfO_2 powders purchased from Aladdin (Left) and prepared by hydrothermal method (Right).
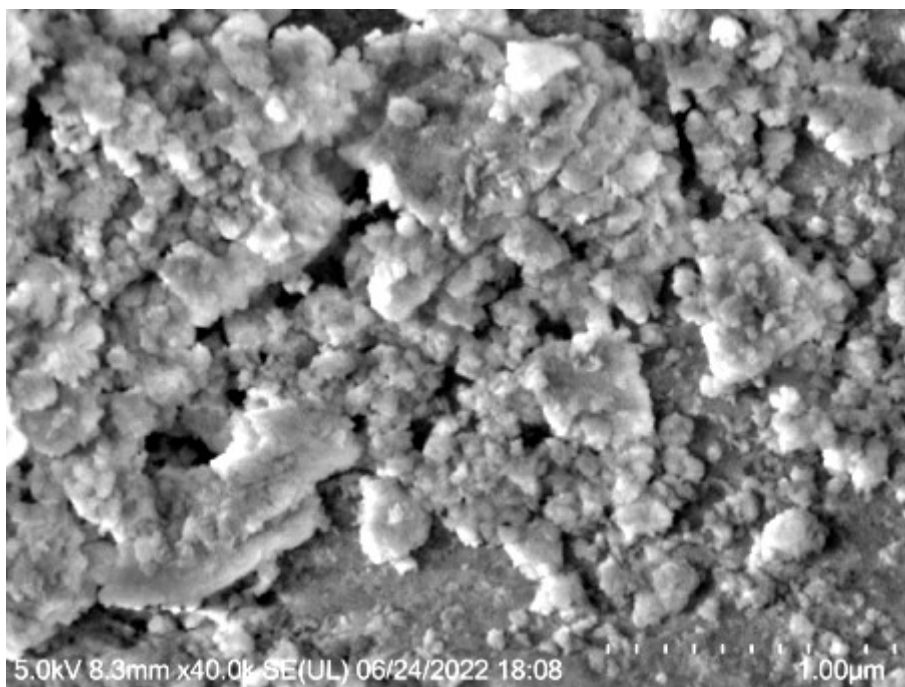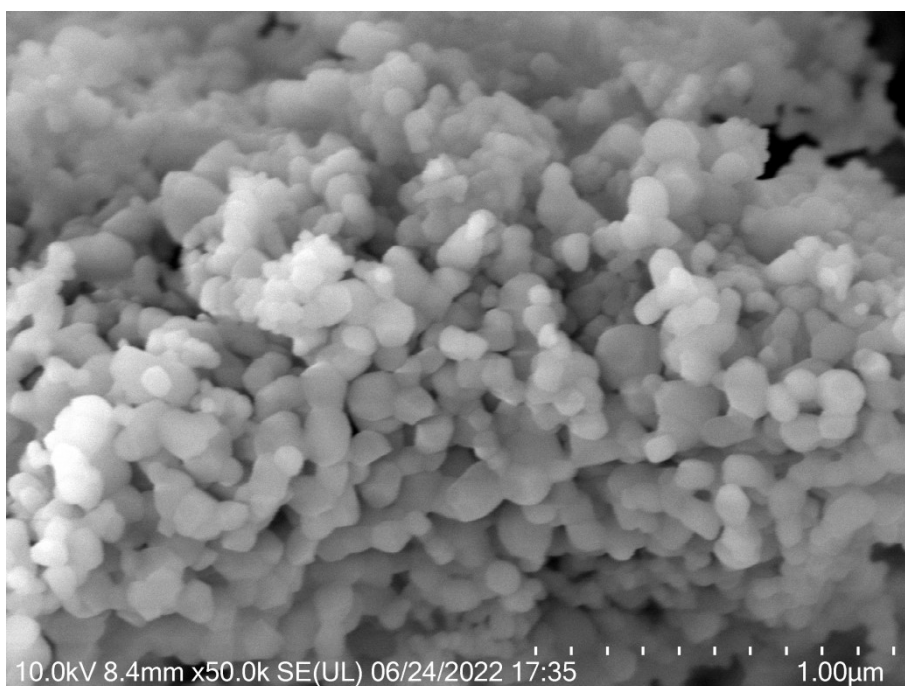
Figure S4 The SEM image of the as prepared HfO_2 sample.

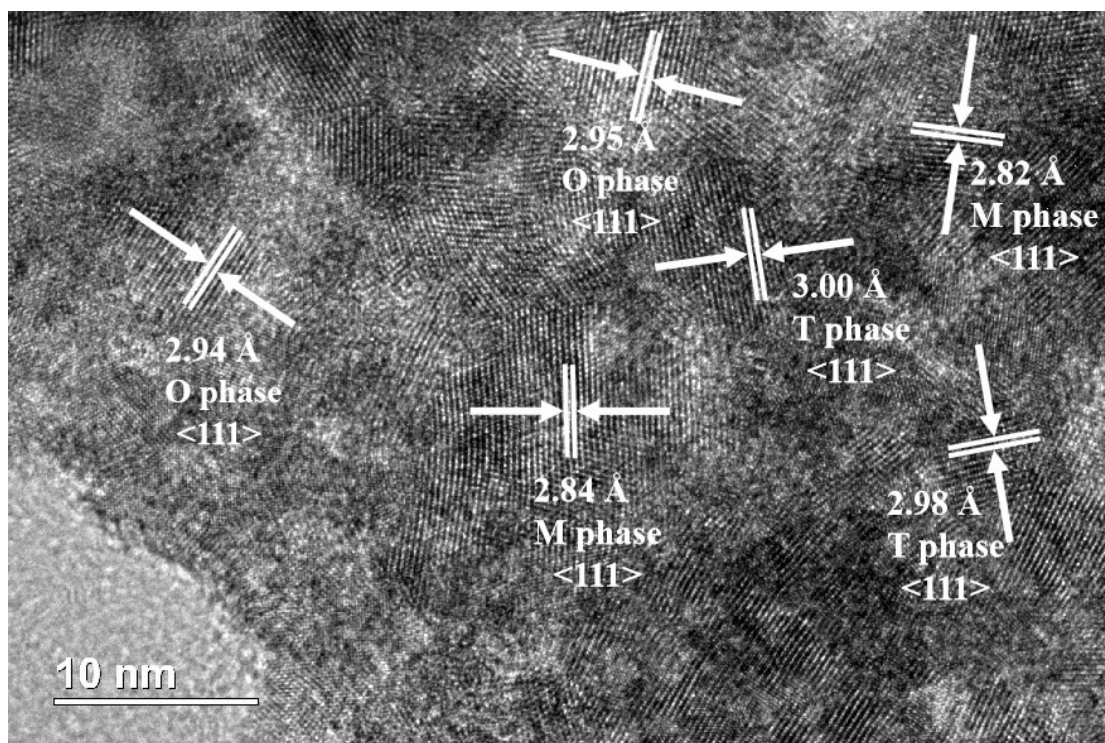Figure S5 The SEM image of the HfO_2 purchased from Aladdin corporation.

Figure S6 The TEM image of the as prepared HfO_2 sample. M, O, and T represent monoclinic, orthorhombic, and tetragonal phases.
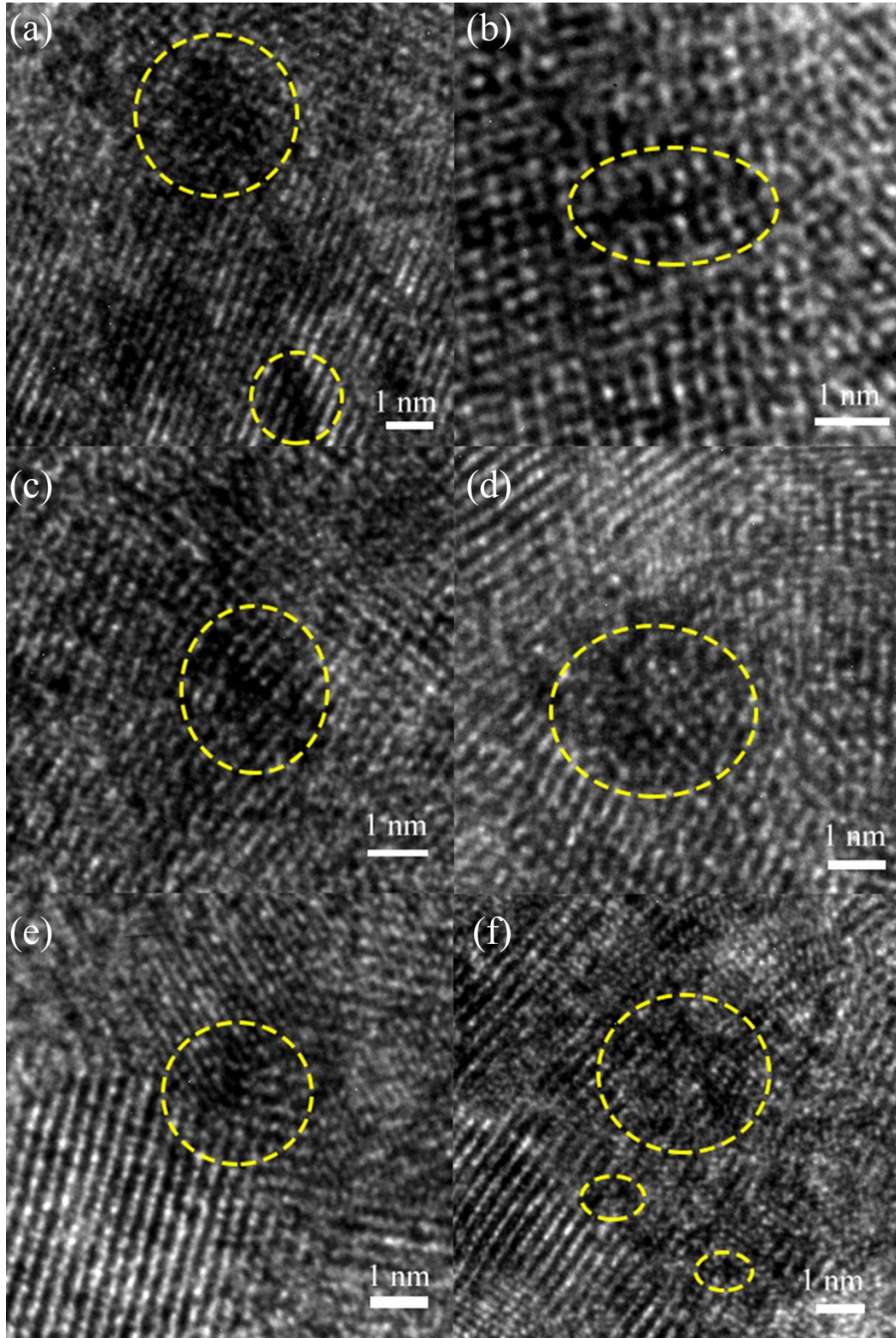
Figure S7 The TEM image of the as prepared HfO₂ sample, in which the lattice vacancies in different regions are clearly identified.
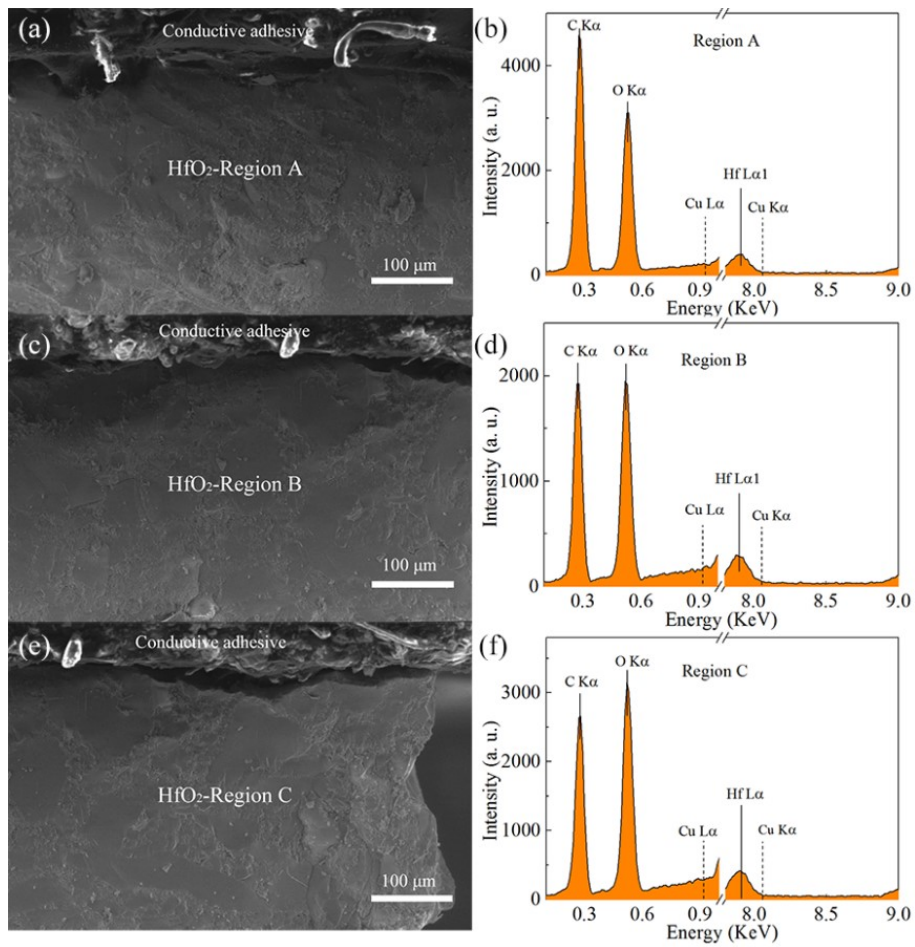
Figure S8 The SEM images and EDS spectra of the HfO₂ MIM device after the measurement.
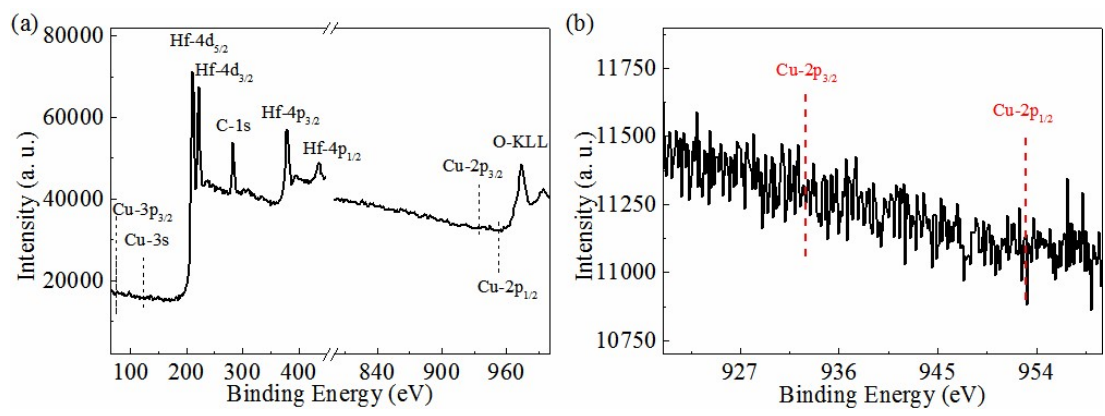
Figure S9 The XPS spectra of the HfO$_2$ MIM device after the measurement.