

Supporting Information

Impact of Zr Top Electrode on Tantalum Oxide-based Electrochemical Metallization Resistive Switching Memory (ReRAM): Towards Synaptic Functionalities

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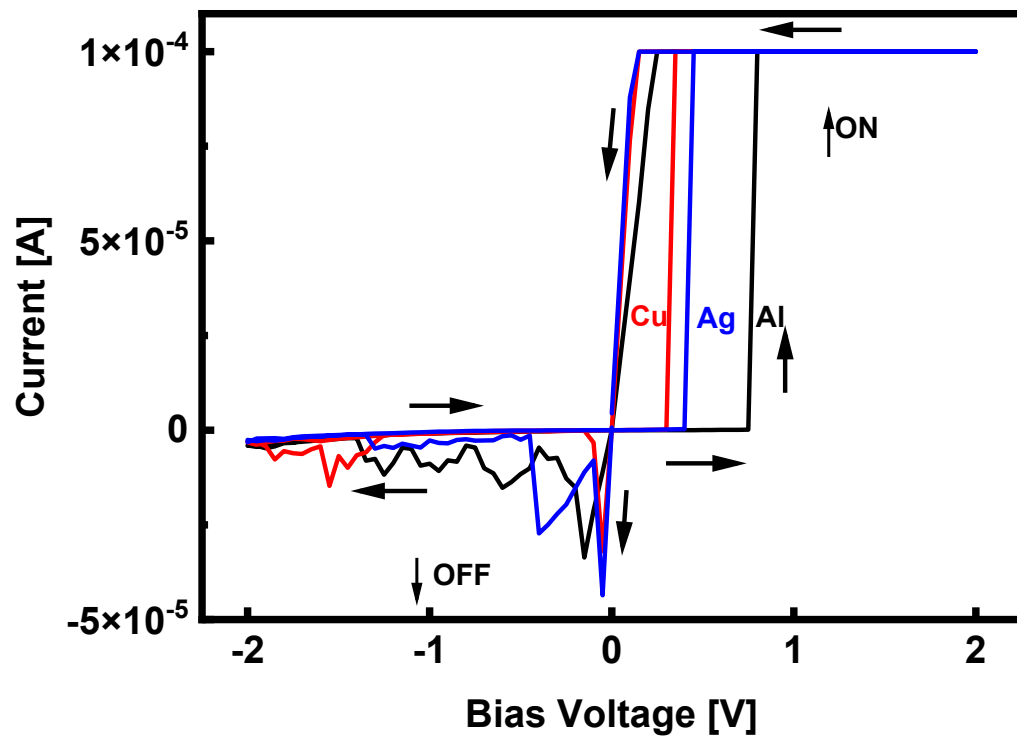
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Reference	On/Off Ratio	Current Level (mA)	Voltage (V)	Bipolar Polarity	Cyclic Voltammetry Measurement	Retention & Endurance	XPS data available	Top Electrode Material	ECM-based ReRAM	Tantalum Oxide form	The structure of the memory device
¹	No	1.5	-1.5, 1	Yes	No	No	No	Ta	No	TaO _x (Ta ₂ O ₅)	Pt/Ta/Ta ₂ O ₅ /Pt
²	No	60	-3, 2	Yes	No	No	No	Ta	No	TaO _x (Ta ₂ O ₅)	Ta/(TaO ₂)Ta ₂ O ₅ /Pt
³	Yes	2	-2, 2	Yes	No	Yes	No	Pd	No	Ta ₂ O _{5-x} /TaO _y	Pd/Ta ₂ O _{5-x} /TaO _y /Pd
⁴	Yes	1	-1, 2	Yes	No	Yes	Yes	Pt	No	Ta ₂ O _{5-x}	Pt/ Ta ₂ O _{5-x} /Ta
⁵	No	3	-1.5, 1.5	Yes	No	Yes	Yes	Ti	No	Ta ₂ O _{3-x}	Ti/Ta ₂ O _{3-x} /Pt
⁶	No	×	×	×	No	No	No	Ta	No	Ta ₂ O ₅	Ta/Ta ₂ O ₅ /Pt
This work	Yes	0.2	-2, 2	Yes	Yes	Yes	Yes	Zr	Yes	Ta ₂ O _{5-x}	Pt / Zr /Ta ₂ O _{5-x} / Pt

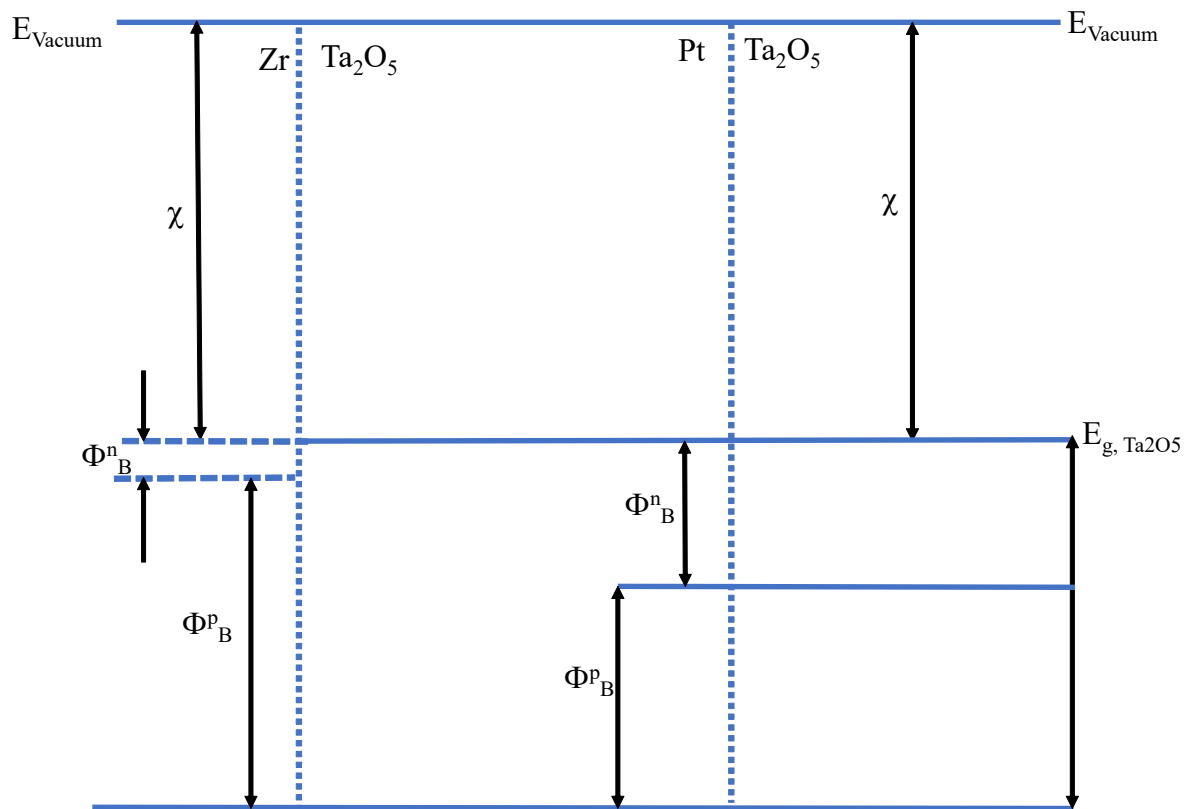
Supporting Table 1. Comparison of different inert top electrode materials on the electrical properties of TaO_x-based VCM ReRAMs.

Reference	On/Off Ratio	Current Level (mA)	Forming Voltage (V)	Voltage (V)	Bipolar Polarity	Cyclic Voltammetry Measurement	Retention & Endurance	XPS data available	Top Electrode Material	ECM-based ReRAM	Tantalum Oxide form	The structure of the memory device
⁷	No	100	6	-3, 3	Yes	No	No	No	Cu	Yes	TaO _x (Ta ₂ O ₅)	Cu/Ta ₂ O ₅ /Pt
⁸	No	compare	No	No	No	No	No	No	Cu	Yes	TaO _x	Cu/TaO _x /Pt
⁹	No	1	No	-1, 1	Yes	No	No	No	Ag	Yes	TaO _x	Ag/ TaO _x /TiN
¹⁰	No	3	No	-.1, .15	Yes	No	No	No	Ag	Yes	TaO _x	Ag/TaO _x /Pt
¹¹	No	1.2n	Yes	-15, 15	Yes	No	No	Yes	Al	Yes	TaO _x	Al/TaO _x /Pt
This work	Yes	0.2		-2, 2	Yes	Yes	Yes	Yes	Zr	Yes	Ta ₂ O _{5-x}	Pt / Zr /Ta ₂ O _{5-x} / Pt

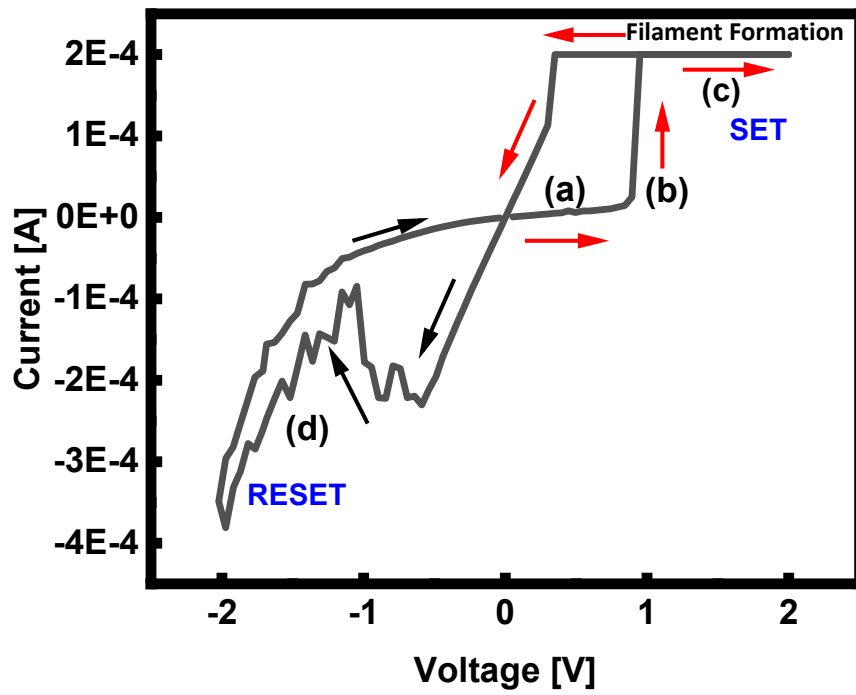
Supporting Table 2. Comparison of different active top electrode materials on the electrical properties of TaO_x-based ECM ReRAMs.



Supporting Figure S1 | I - V characteristics of the resistive switching memory device with different top electrodes of Al, Ag, and Cu.



Supporting Figure S2 | Energy band diagram for Zr and Pt electrodes in contact with Ta₂O₅ insulator layer.



Supporting Figure S3 | linear I - V characteristics of the resistive switching memory device

References:

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