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Supporting Information

Decoding the metallic bridging dynamics in nanogap atomic switches

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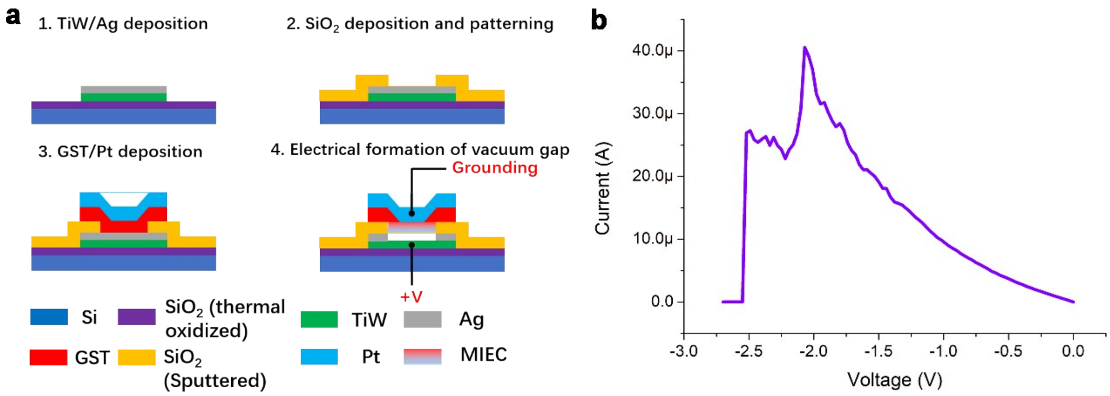

Figure S1. (a) Process flow of the vacuum gap device: 1. Bottom electrode and active metal layer deposition; 2. Dielectric layer deposition followed by opening a 2 × 2 μm^2 window on the dielectric layer; 3. Chalcogenide layer and top electrode deposition and patterning; 4. Electrical formation of the vacuum gap, by applying a electrical field from bottom electrode to top electrode, we can drive the Ag layer into the chalcogenide layer. (b) I-V characteristic during the electroforming of vacuum gap between the functional layer (Ag-GeSbTe) and bottom electrode (TiW). Before electroforming, the OFF current was rather high due to the conductivity of Ag-GeSbTe mixed ionic and electronic conductor (MIEC). After electroforming, the OFF-state current abruptly dropped to less than 1 pA, indication the formation of the insulating vacuum gap. Inset: log scale plot of the I-V curve.

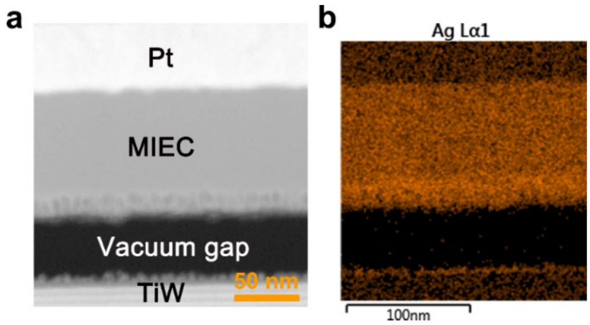

Figure S2. Cross sectional view of a pristine prototype gap-type atomic switch. (a) STEM image of a pristine gap-type atomic switch. (b) EDX mapping capturing the Ag distribution in a pristine gap-type atomic switch.

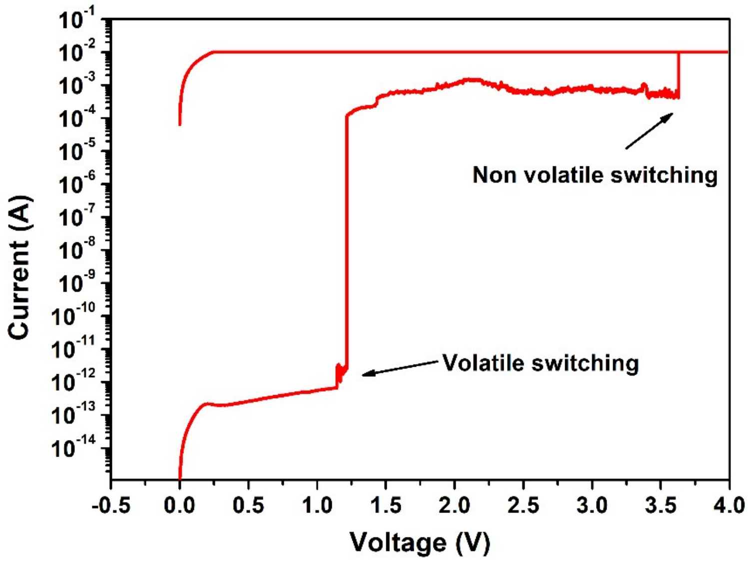

Figure S3. I-V curve showing volatile and non-volatile switching of gap-type atomic switch.

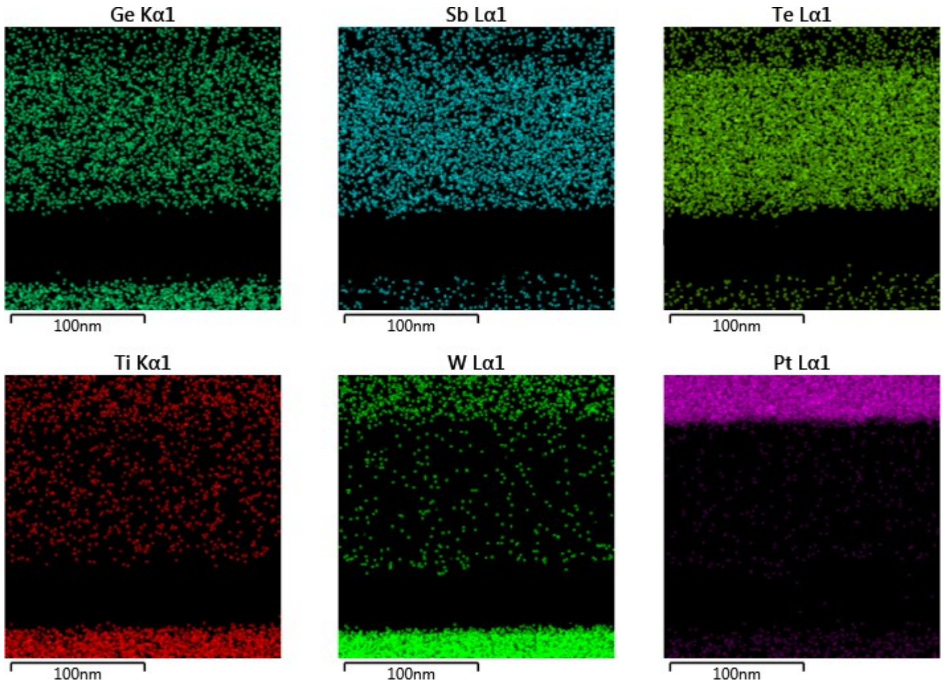

Figure S4. EDX mapping capturing the distributions of Ge, Sb, Te, Ti, W and Pt in a low resistance state atomic switch.

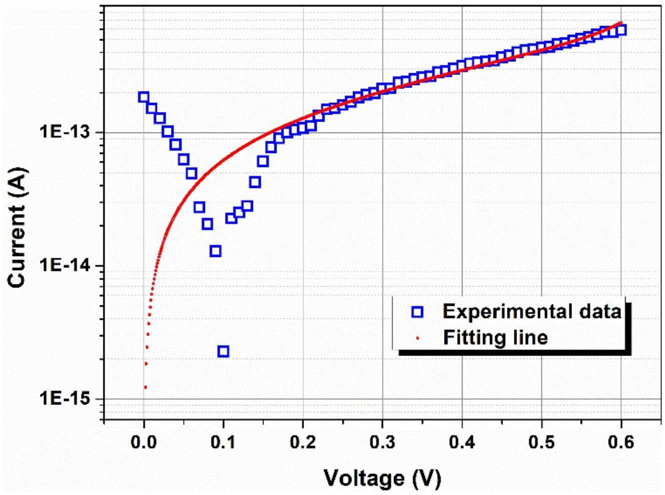

Figure S5. Fitting for the tunneling current at low voltage range to decide the characterization parameters: I_0, x_T, V_T.

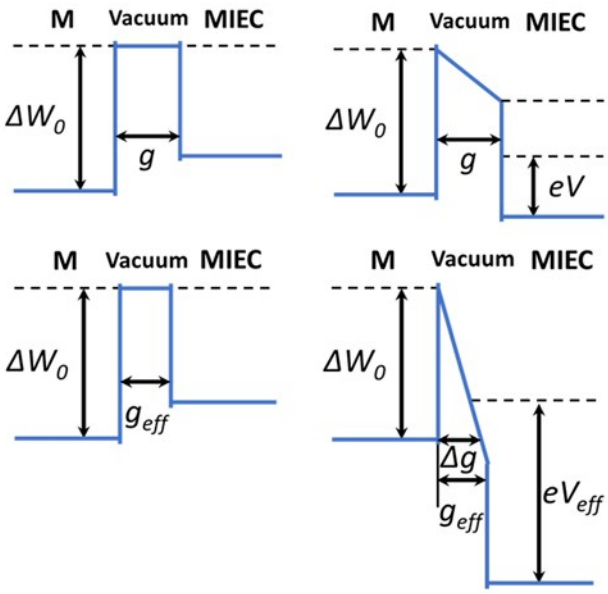

Figure S6. Energy-band diagram of the vacuum gap device in different voltage regime: low and high. The barrier height ΔW_{Ag} is the work function of Ag is about 4.26 eV.