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

Supporting Information

Refresh Operation Method for Solving Thermal Stability Issue and Improving Endurance of Ovonic Threshold Switching Selector

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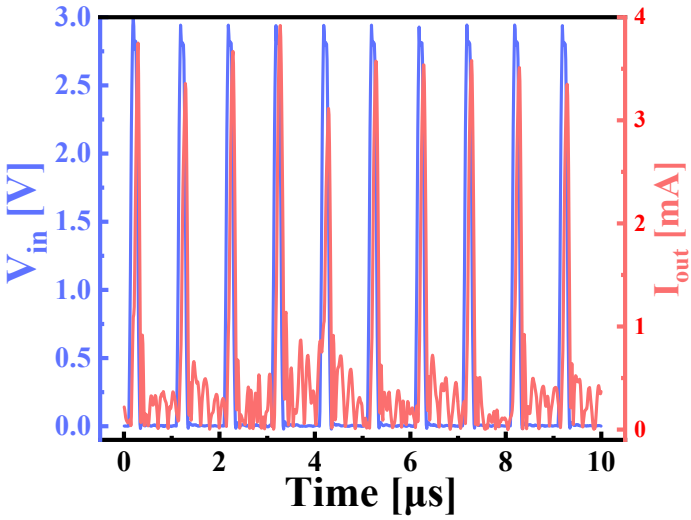

Figure S1. The dynamic response to a sequence voltage pulse of the refreshed 350 ℃ anneal-failed GeTe selector.

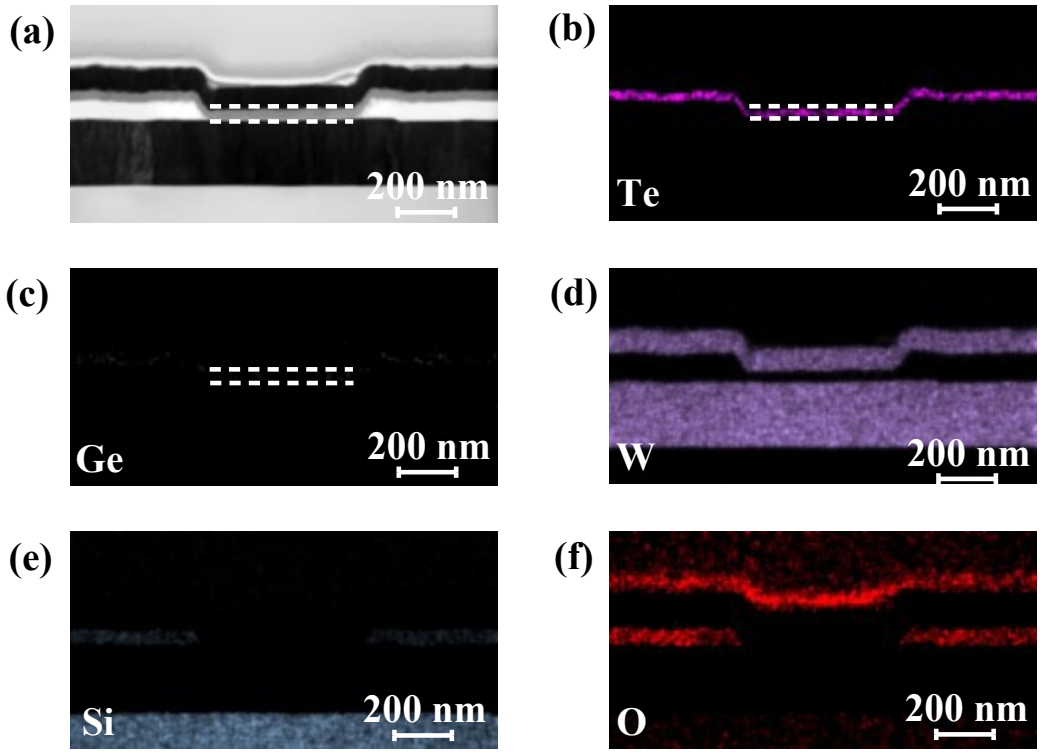

Figure S2. The elemental distribution profiles of the GeTe-based device at the failure state. (a) The The cross-sectional TEM image of the failed GeTe selector. The scale bar is 200 nm. Element distribution of (b) Te, (c) Ge, (d) W, (e) Si, (f) O.

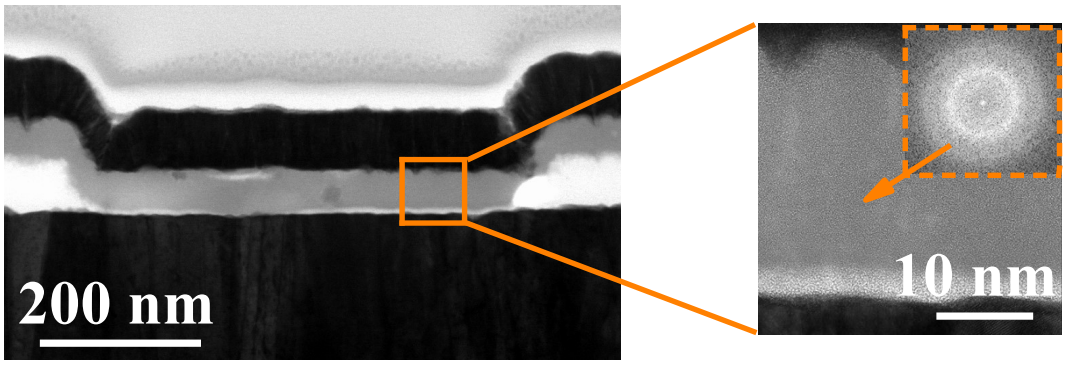

Figure S3. HRTEM analysis and FFT pattern results for the GeTe layer before the cycle repetition

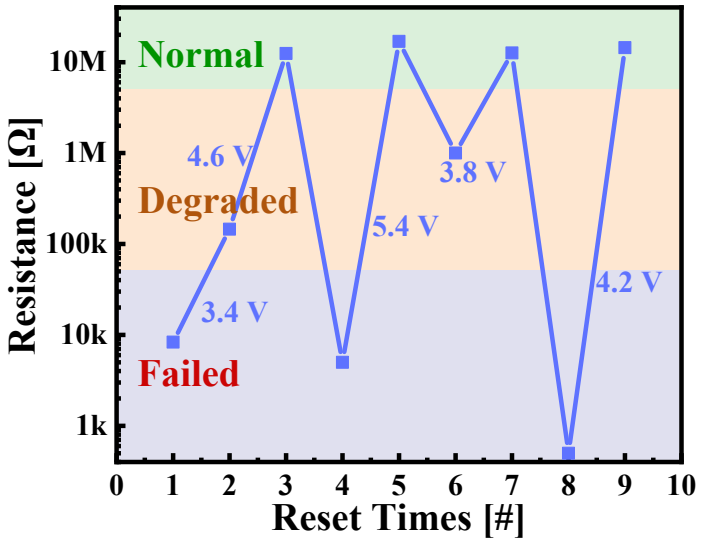

Figure S4. Multiple RESET operations in one device. The switching state is divided into three different states according to the device resistance. The device resistance is read at 0.5 V using a DC voltage sweep. We consider devices with resistance below 50 kΩ to failure, with resistance above 5 MΩ to normal, while with resistance mediate to degradation. By applying Reset pulses with various amplitudes, the degraded and failed devices can be repetitively refreshed to the normal switching state.

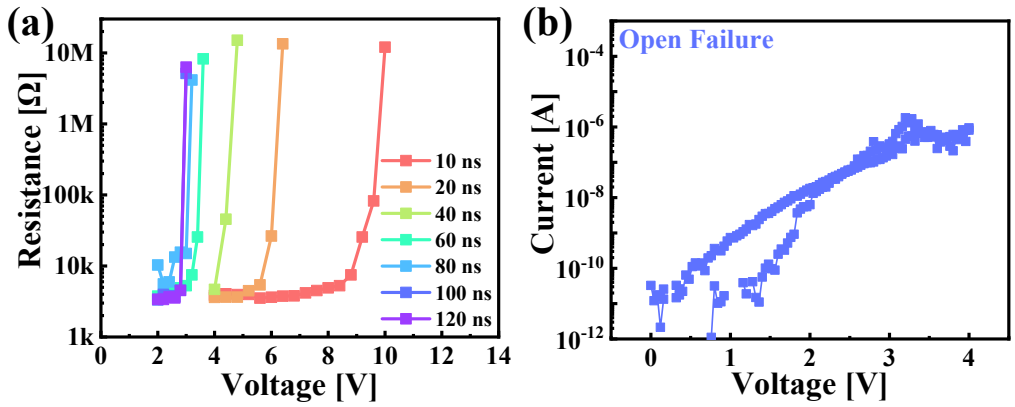

Figure S5. (a) Refresh results under different pulse width; (b) Device open fail under refresh pulse with over large amplitude

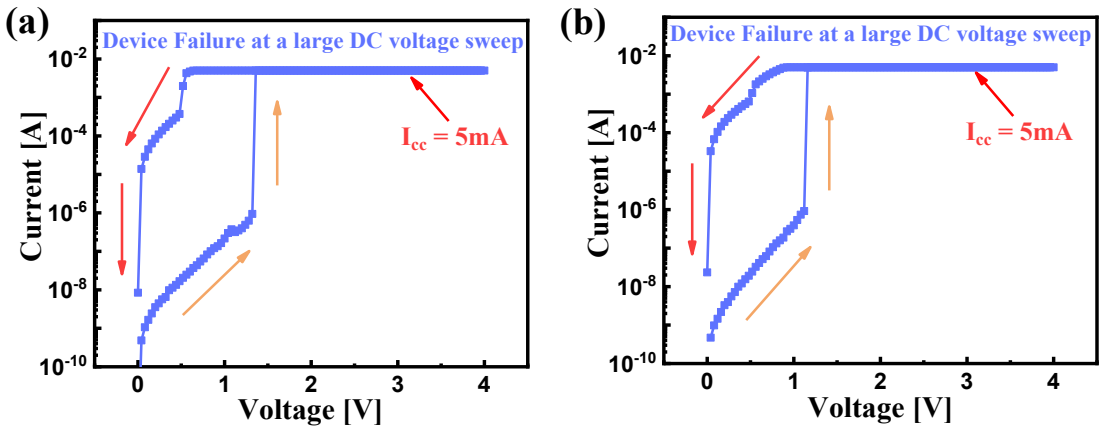

Figure S6. The accelerating failure process of two devices using a large DC voltage sweep with compliance of 5 mA. These two devices have been through a forming process and remain a large resistance at the subthreshold region. Different from the AC operation, the DC sweep will last a long time and offer more energy especially when a larger compliance current is applied. During the positive sweep, the devices shows a normal threshold switching process and the device resistances decrease. While in the negative sweep, the devices remain a low resistance and barely no switching-off process can be found.

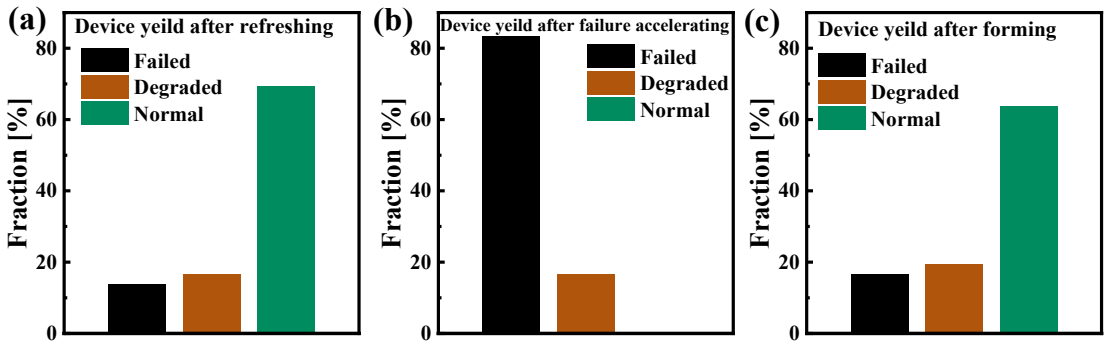

Figure S7. Fraction of the of the devices after (a) The forming process, (b) The failure accelerating process, (c) The refresh operation.

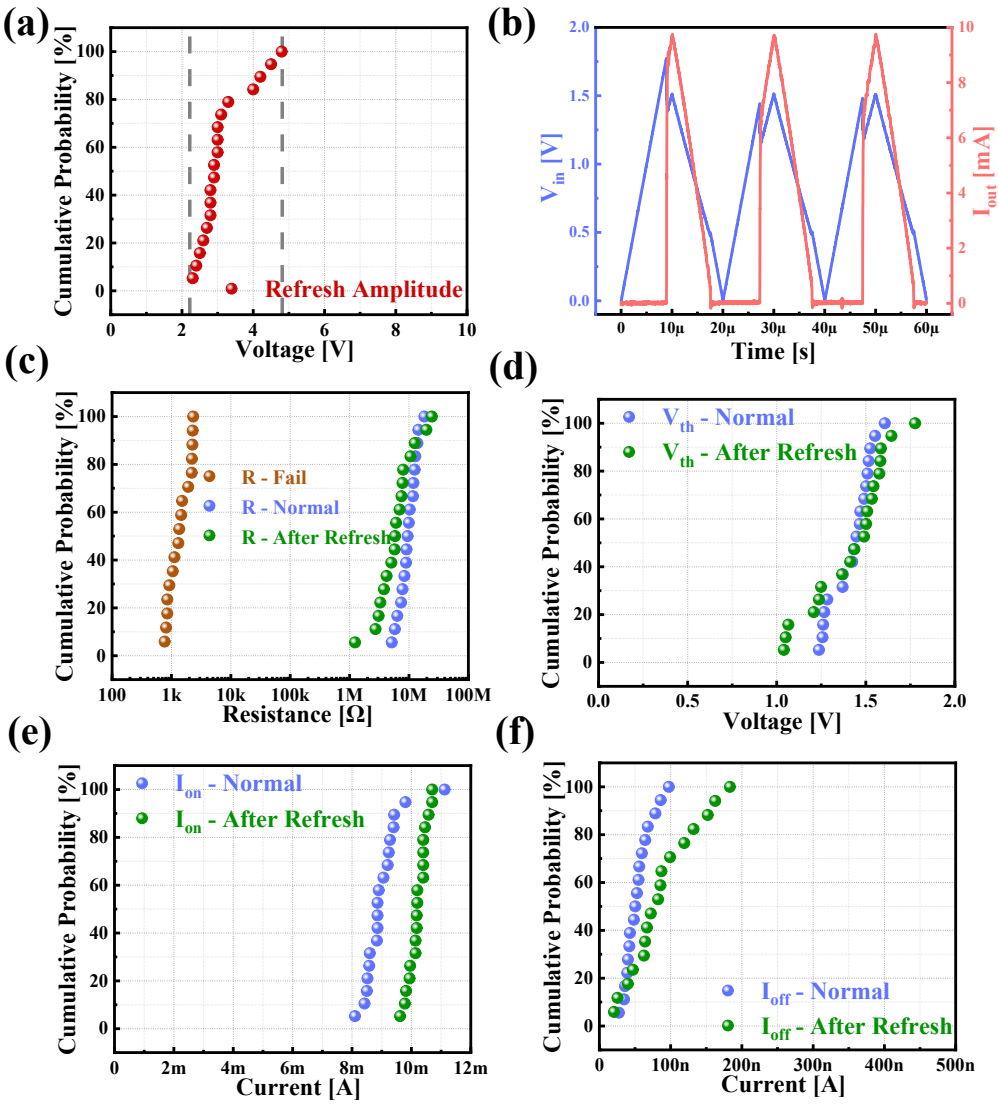

Figure S8. The comparison of typical threshold switching performance of GeTe selectors with feature size of 1250 nm. (a) The voltage amplitude distribution of the refresh pulses of failed GeTe selectors. (b) The switching characteristic under the

triangle pulse in the device after the refresh operation. (c) The resistance distribution of the GeTe selectors before devices fail, after devices fail and after devices are refreshed. The device off-resistances are read at 0.5 V. (d) The threshold voltage distribution of the GeTe selectors. (c) The on-current distribution of the GeTe selectors. (f) The off-current distribution of the GeTe selectors.