Short-Term Memory to Long-Term Memory Transition in a Nanoscale Memristor

Supporting Information

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The Weibull Distribution

The two-parameter probability density function (*pdf*) of a Weibull distribution is[1]

$$f(x,\lambda,k) = \begin{cases} \frac{k}{x}\left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)^k} & x \geq 0, \\ 0 & x < 0, \end{cases} \quad \text{(S1)}$$

, where k>0 is the shape parameter and λ>0 is the scale parameter. The corresponding cumulative density function (*cdf*) is

$$F(x;k,\lambda) = 1 - e^{-(x/\lambda)^k} \quad \text{(S2)}$$

for $x \geq 0$, or else $F(x; k, \lambda)=0$.

From eq S1 and S2, the survival function (*i.e.* the complementary *cdf* of Weibull) is

$$S(x) = e^{-(x/\lambda)^k} \tag{S3}$$

, which has the form of a stretched-exponential function.

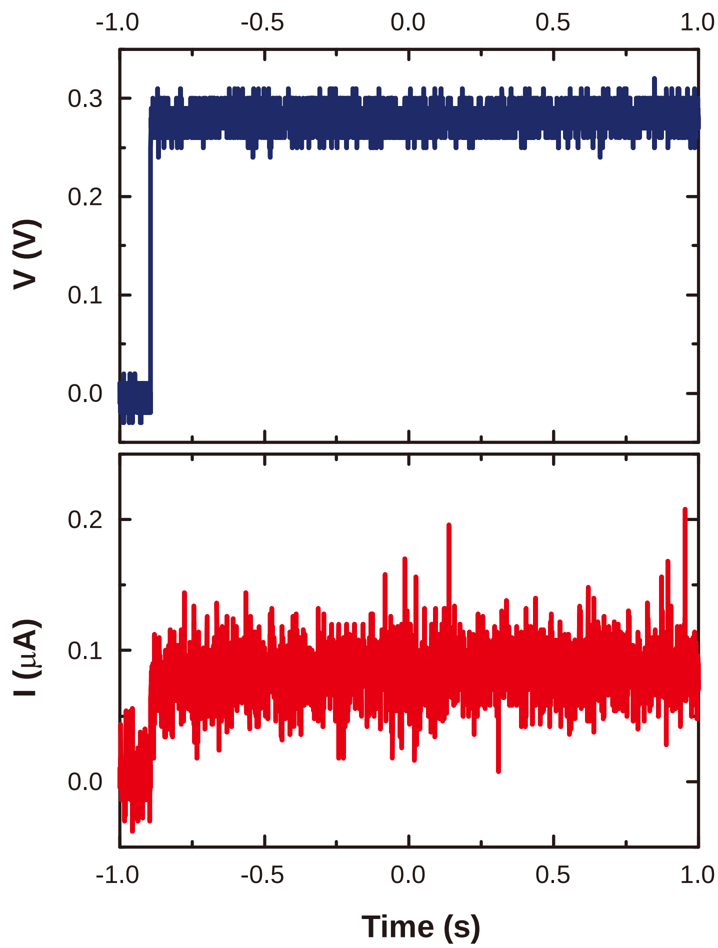

Figure S1. Effects of the read voltage on the memristor. The top panel shows the application of a constant read voltage of 0.3 V used in the studies and the bottom panel shows the corresponding current. The current stays at a stable level within the measured timeframe, proving that a small read voltage of 0.3V has negligible effect on the memristor device.

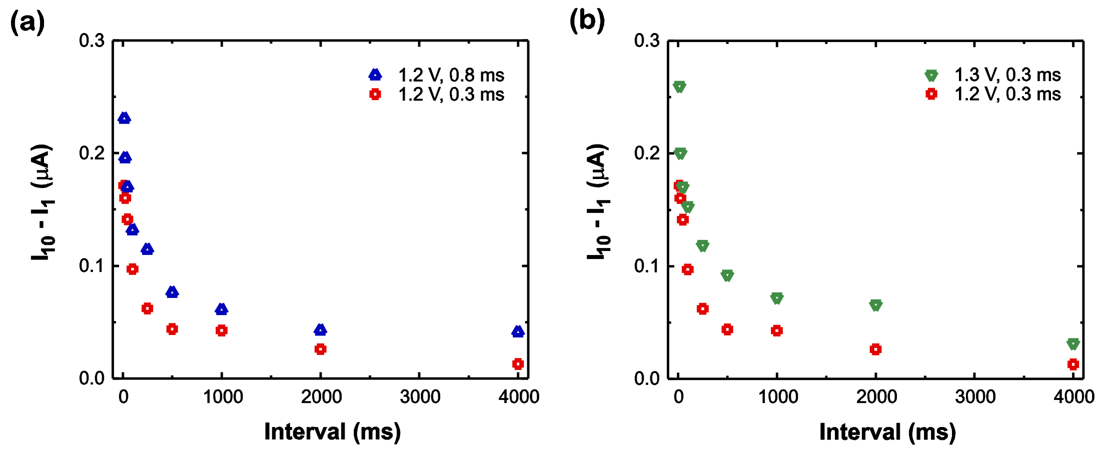

Figure S2. Effects of the pulse duration and pulse amplitude on STM-LTM transition. The stimulation pulse interval was fixed at 60 ms. $I_{10} - I_1$ was measured against stimulation rates for (a) different pulse durations and (b) different pulse amplitudes. Longer pulse duration and larger pulse amplitude both lead to larger I_{10}-I_1, and hence are more effective in the memory transitions.

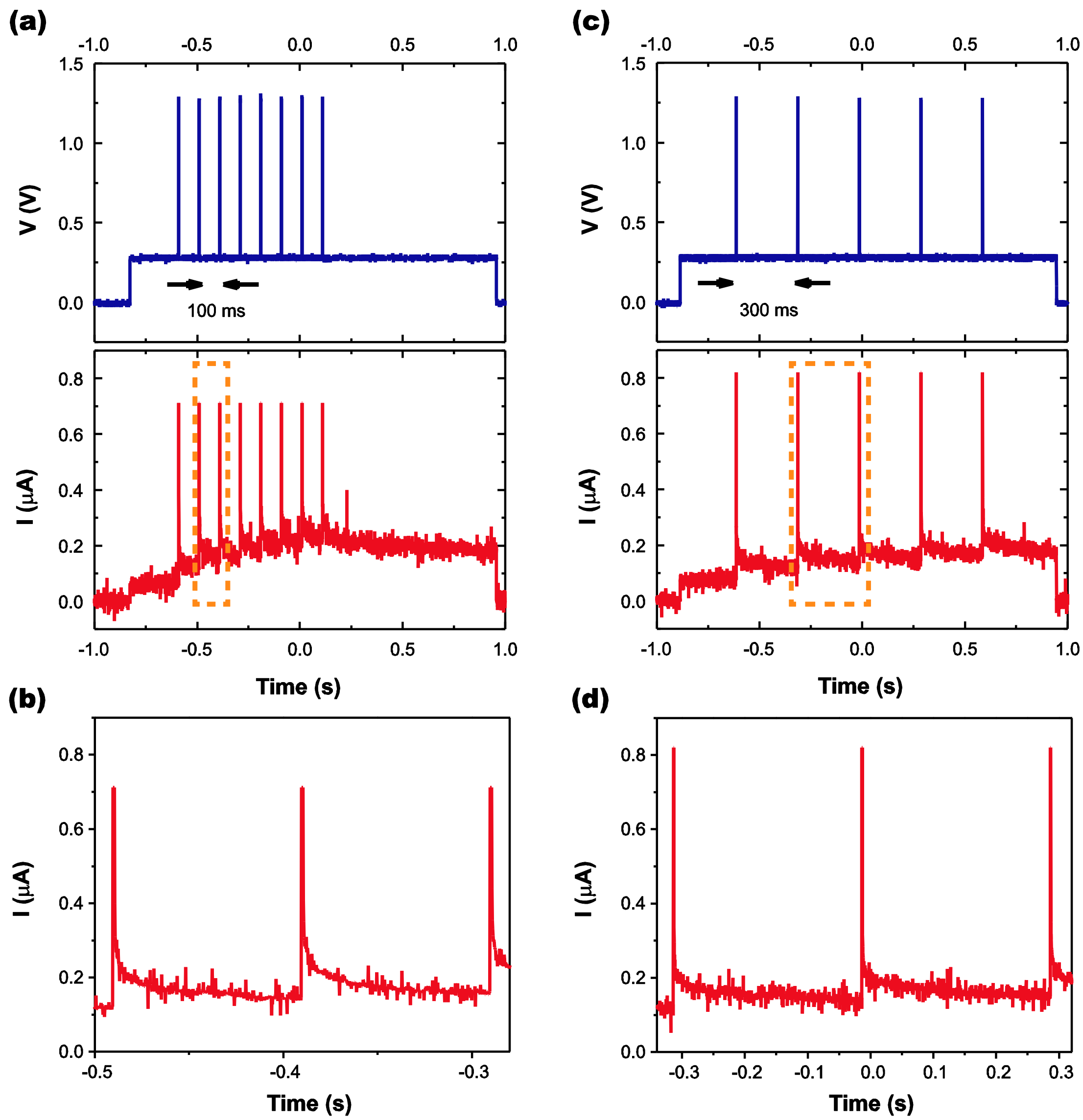

Figure S3. Effects of the pulse interval on STM-LTM transition. Same methods used as in Figure 2b, except the interval was changed to (a) 100 ms and (c) 300 ms. (b) and (d) are zoomed-in views of the rectangular areas in (a) and (c), respectively. Stimulations with shorter pulse interval (*i.e.* higher stimulation rate) are clearly more effectively in causing the memory transitions, in agreement with the observation in Figure 4.

References

1. Schroder, D. K. *Semiconductor Material and Device Characterization*, 3rd ed.; IEEE Press: New Jersey, 2006.