Supporting Information

Electronic imitation of behavioral and psychological synaptic activities by the TiO$_x$/Al$_2$O$_3$-based memristor devices

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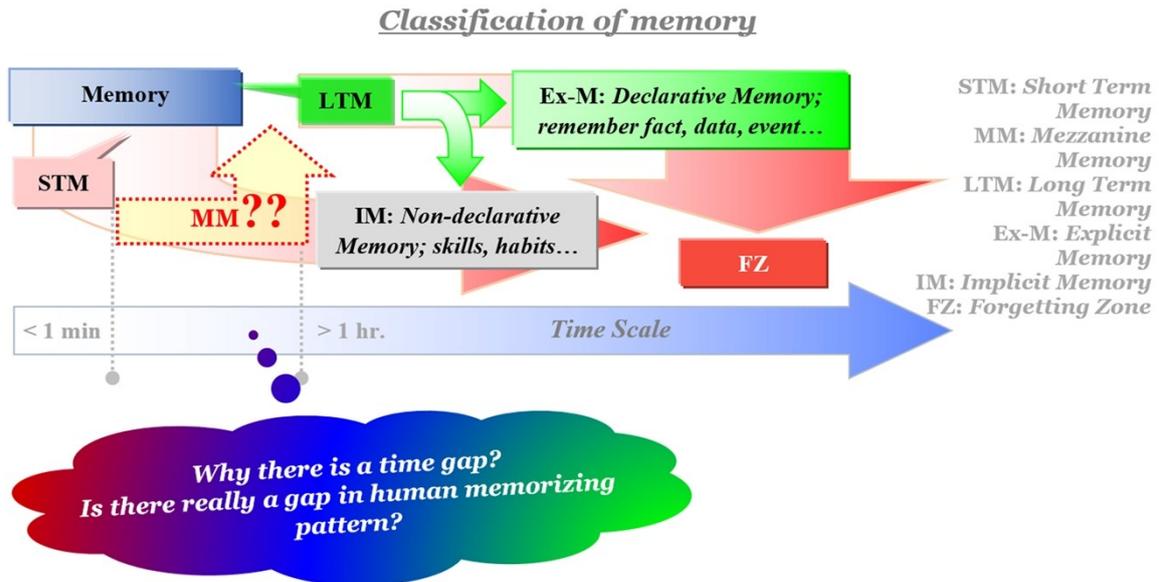
Figure S1: Classification of real-life memory. Different memorizing abilities of biological memory depends on the retention time. The STM can retain stored information for < 1 min. and the LTM can retain for > 1 hr. All kinds of memory can go to the forgetting zone. An obvious question arises here that is there really a gap between STM and LTM? Or there is some hidden memorizing level. Don't know for human brain but for the electronic synapse we define the mezzanine level as mezzanine memory (MM). The retention of the MM level of TiO_x/Al_2O_3-ESJ is > 1 min. to < 1 hr.
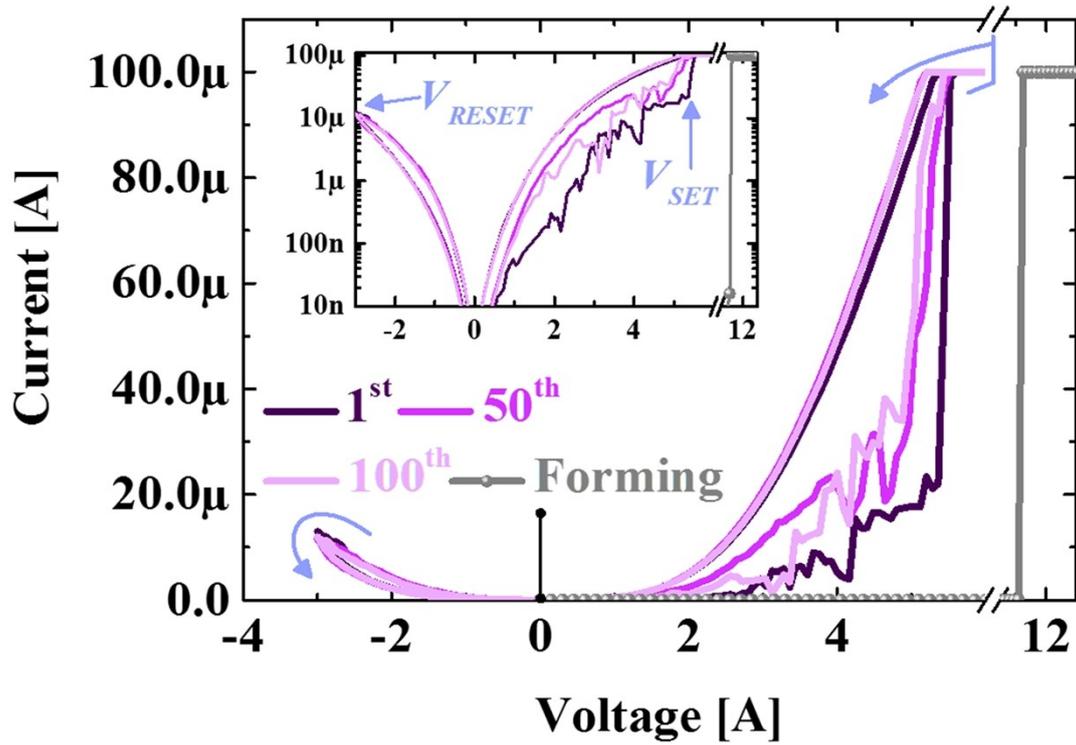
Figure S2: Current-voltage characteristics in TiO$_x$/Al$_2$O$_3$-based memristor. The TiO$_x$/Al$_2$O$_3$-based memristor devices can show stable resistive switching performances. Initially, about +12 V is required to form the device and the switching happens afterward. The current level was fixed at 100 μA during the continuous measurement of the TiO$_x$/Al$_2$O$_3$-based memristor devices.
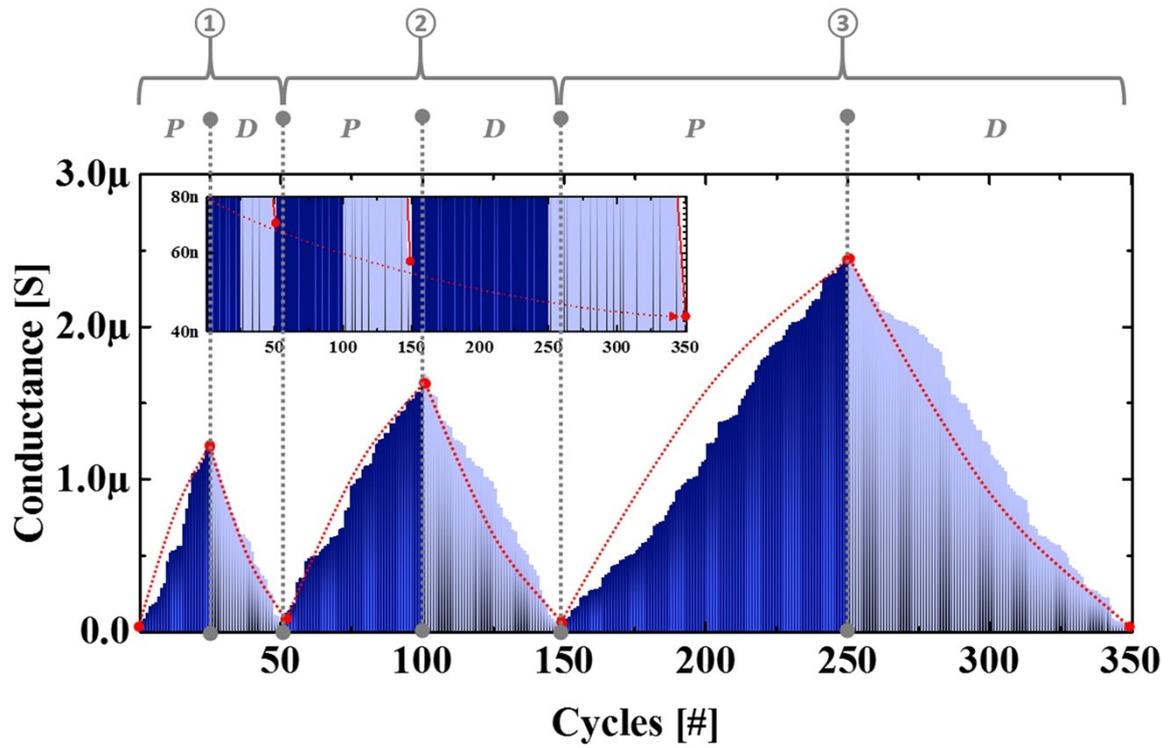
Figure S3: Potentiation and depression in TiO$_x$/Al$_2$O$_3$-ESJ. The cycle dependent variation of the *P* and *D*. During potentiating, the synaptic weight is continuously increasing with the cycles. During depressing, the synaptic weight is continuously decreasing with the cycles, as shown in the inset.
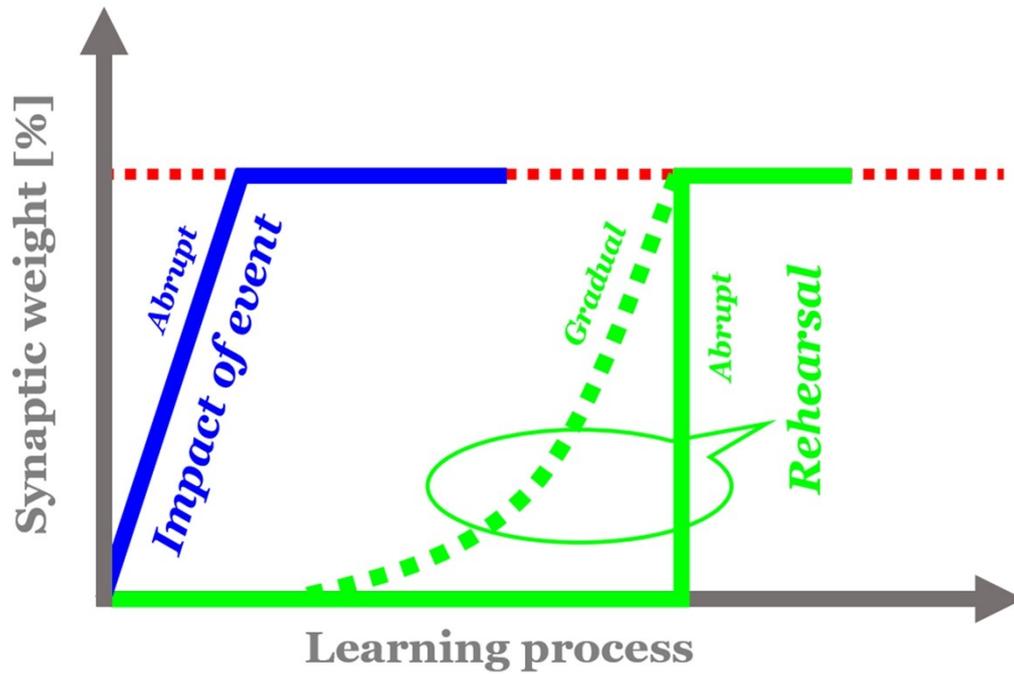
Figure S4: Rehearsal and impact of event dependent learning in ESJ. The rehearsal process is mostly a gradual increment of the synaptic weight. In contrast, the impact of event is mainly related to the abrupt transition.
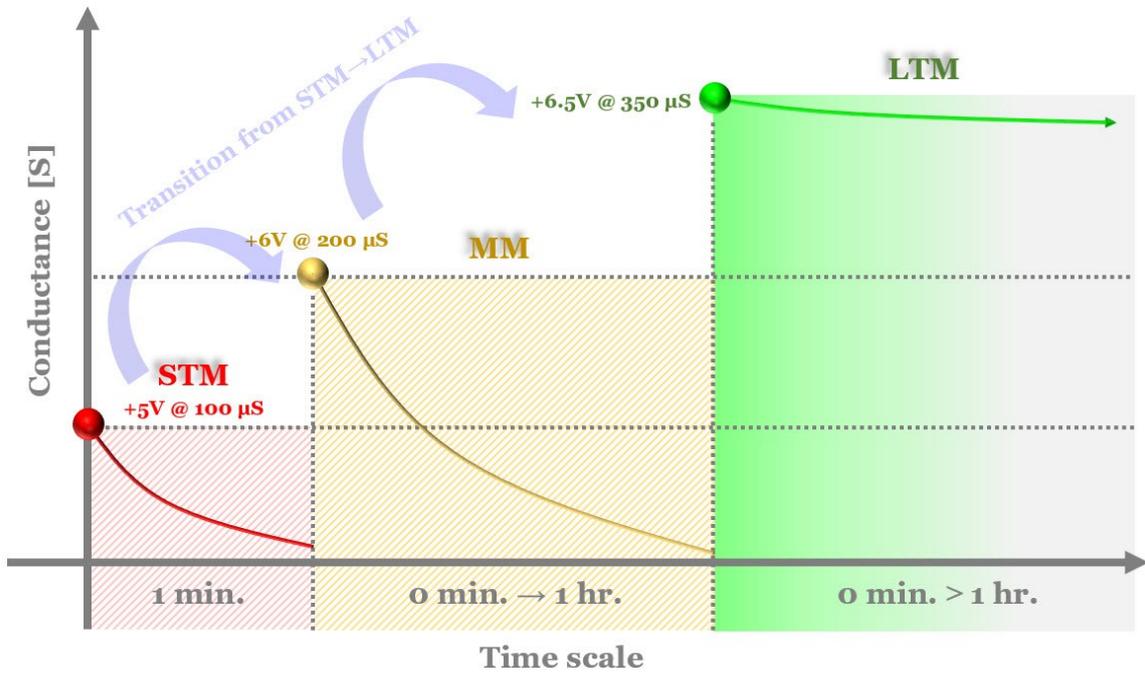
Figure S5: Transition from STM to LTM. The transition process from STM to LTM is very much dependent on the applied pulse conditions.