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## Supplementary materials

# Effect of interfacial $SiO_2$ layer thickness on the memory performances in $HfAlO_x$-based ferroelectric tunnel junction for neuromorphic system

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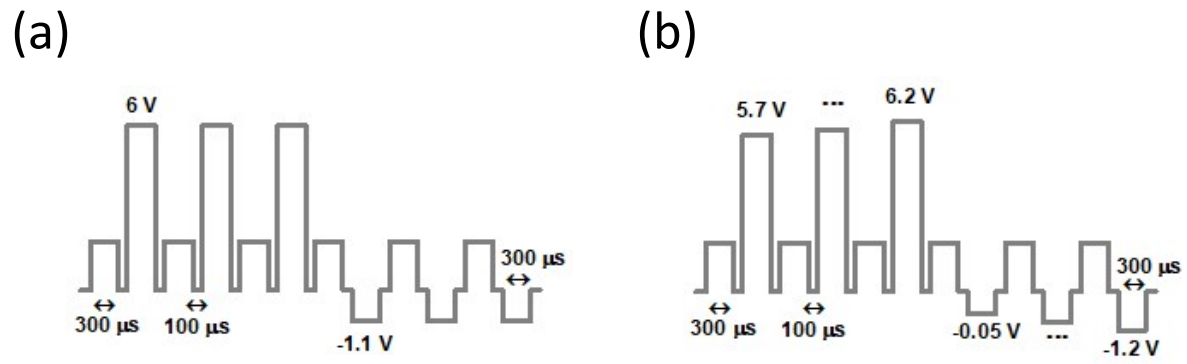


**Fig. S1** (a) Identical and (b) incremental pulse schemes for potentiation and depression.

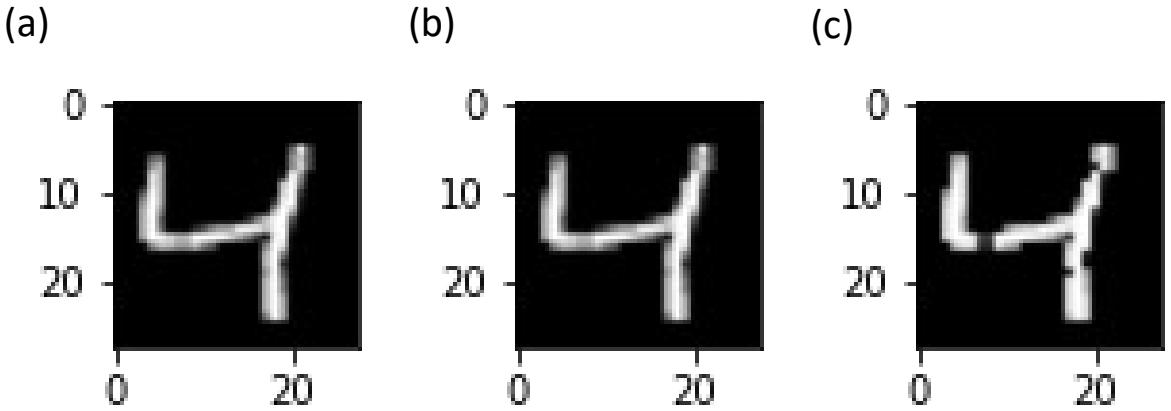


**Fig. S2** Hand-written recognized MNIST numbers with respect to cycles of training of number 4 of (a) the ideal, (b) the incremental pulse scheme, and (c) the identical pulse scheme.