Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information for

Biopolymer based artificial synapse enables linear conductance tuning and low-power for neuromorphic computing

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S1: Peak shifting and band assignments of both compounds

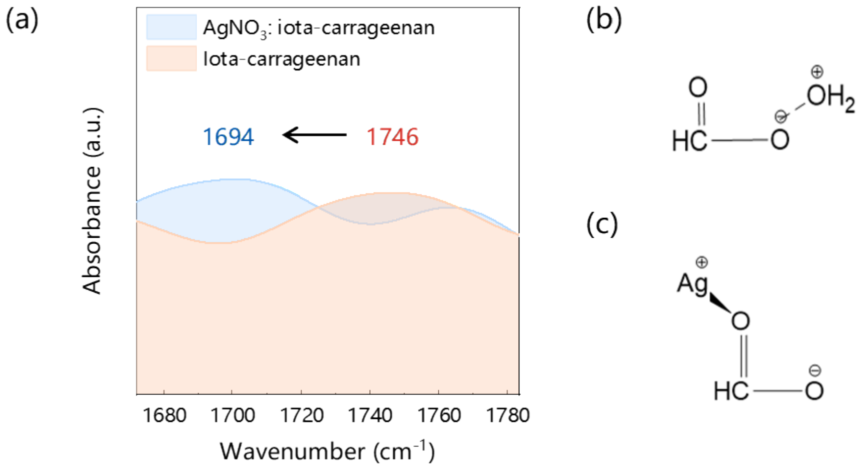

Figure S1 (a) Enlarged FTIR spectra illustrating the peak at 1746 cm^{-1} in the pristine carrageenan shifted to 1694 cm^{-1} in the doped carrageenan due to C=O stretching mode transformation; (b) asymmetric stretching mode caused by electrostatic interactions; (c) symmetric stretching mode caused by ion dipole interactions between Ag ions and oxygen atoms in C=O

Table S1 FTIR band assignments of modified carrageenan and native carrageenan thin film samples

Peak NO.	Modified carrageenan (cm^{-1})	Carrageenan (cm^{-1})	Assignment
1	648	657	Skeleton bending
2	700	713	Skeleton bending
3	756	779	d-galactose
4	856	885	C-H stretching
5	1039	1049	C-O-C stretching
6	1231	1244	Sulphate ester
7	802	-	NO_2 stretching
8	1694	1746	C=O stretching
9	2318, 2378	2285, 2366	H_3O^+

S2: Nanopore's statistic distribution analysis

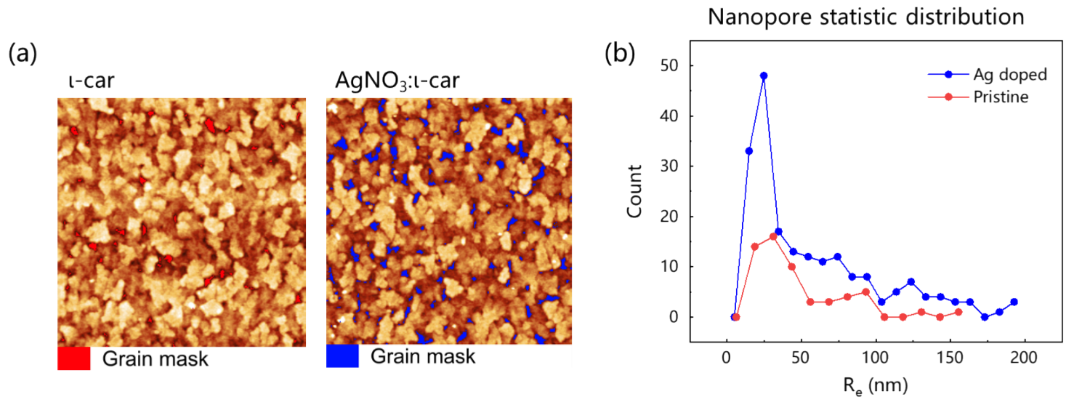

Figure S2 (a) AFM images of ι-car and $AgNO_3$: ι-car with nanopore(grain) masked by red and blue color, respectively; (b) statistic distribution of the number and minimum circumcircle radius (R_e) of nanopores

The software Gwyddion was used to mark the nanopores' distribution under certain threshold conditions (>20% in depth), count the number, and the Minimum circumcircle radius (R_e) of nanopores. Here the parameter R_e meaning the radius of the minimum circle that contains the grain was used to evaluate the pore's size. **Figure S2 a** shows the processed AFM spectra of ι-car and Ag doped ι-car surfaces with the pores marked by red and blue color. The counting results given in **Figure S2b** demonstrate an apparent increase in pore counts and more concentrated pores' distribution in the Ag doped film. The porous structure which was reported to be able to confine the growth of metal filaments and therefore can stabilize the resistive switching process might play a similar role in our device.

S3: The simulation of human brain forgetting behaviors

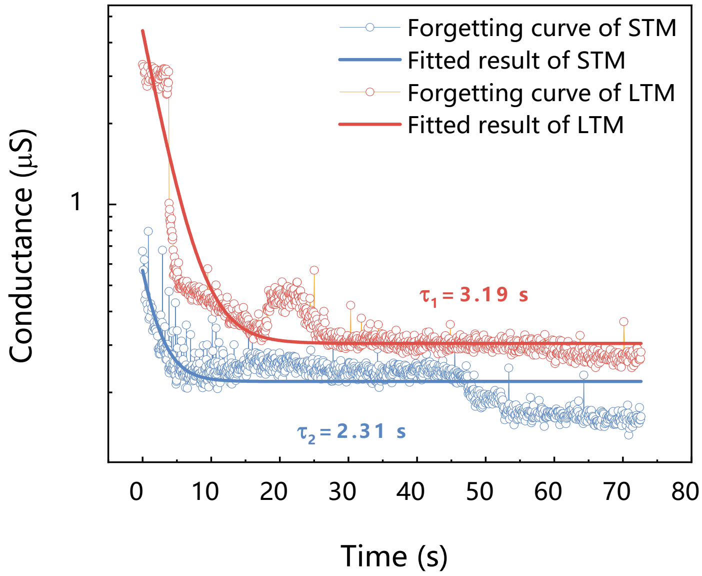

Figure S3 The fitted results for long-term memory (LTM) and short-term memory (STM)

S4: Experimental and fitted potentiation-depression curves

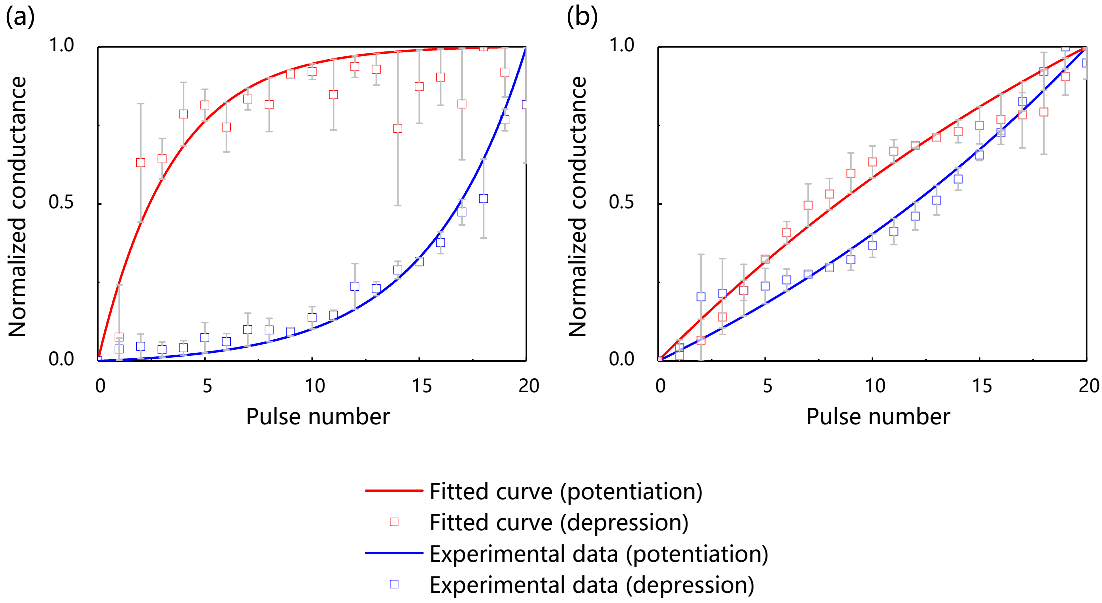

Figure S4. The experimental and fitted results of the potentiation-depression curve for a) undoped memristor and b) $AgNO_3$ doped memristor

S5: Enlarged LTP and LTD curves

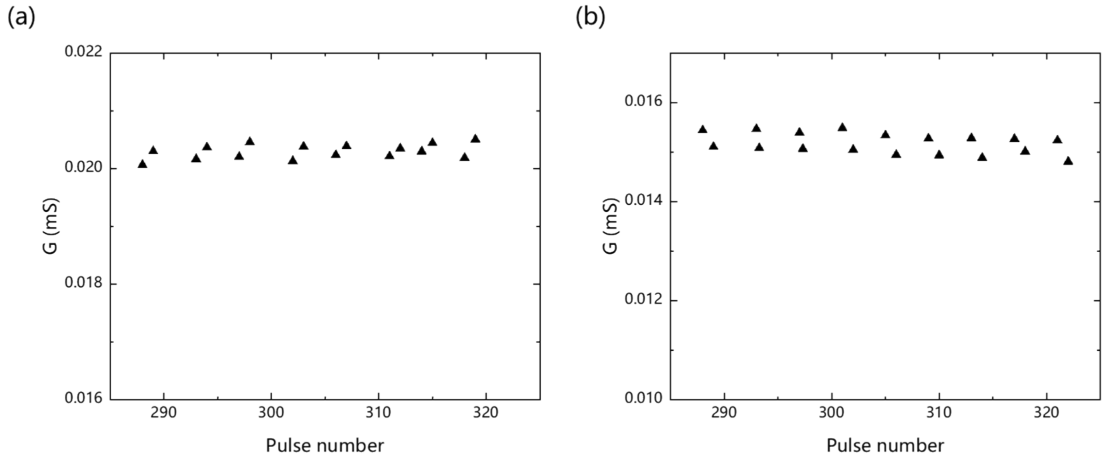

Figure S5. The enlarged potentiation-depression curve for a) LTP and b) LTD, indicating the temporal stability of conduction states over about 30 pulses