

Solidum alginate gated oxide dendritic transistor for spatiotemporal arithmetic application

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Supporting Information

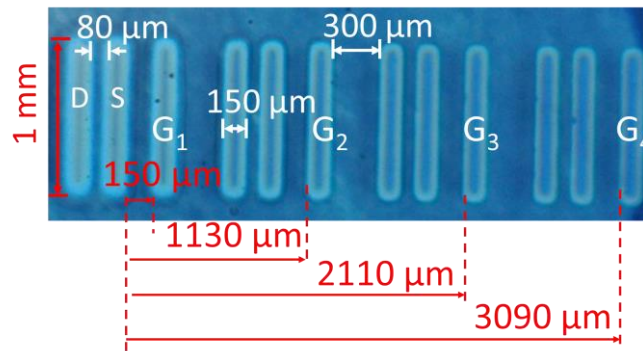


Fig. S1 Top-view photograph of the ITO dendrite transistor.

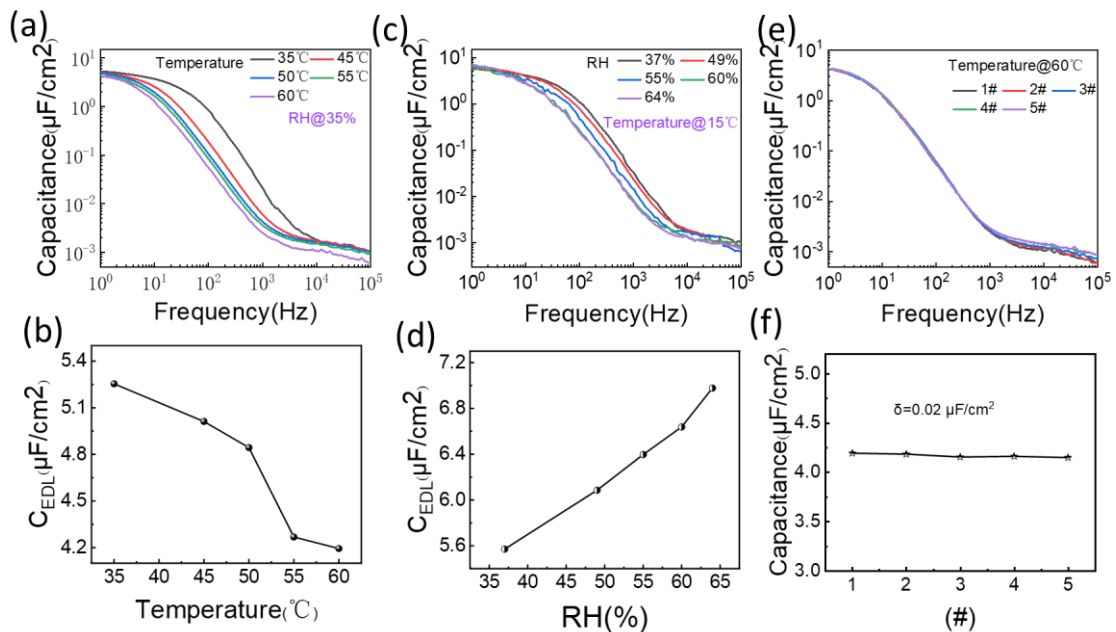


Fig. S2 (a) Frequency dependent specific capacitance at different temperature with fixed RH at 35%. (b) C_{EDL} values extracted from (a). (c) Frequency dependent specific capacitance at different RH with fixed temperature at 15°C. (d) C_{EDL} values extracted from (c). (e) Frequency dependent specific capacitance at fixed RH of 35% and fixed temperature at 60°C. (f) C_{EDL} values extracted from (e).

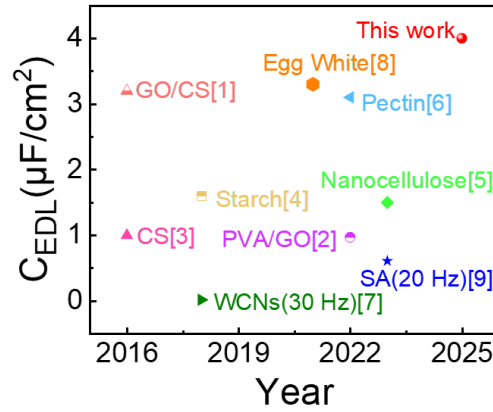


Fig. S3 C_{EDL} values of the present electrolyte with the previously reported ones.

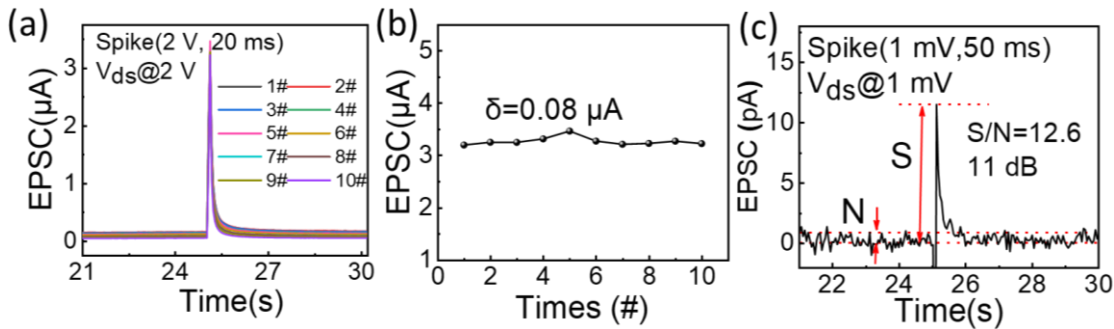


Fig. S4 (a) EPSC responses triggered by loading spike (2 V, 20 ms) on G_1 for ten times. V_{ds} is fixed at 2 V. (b) Extracted EPSC amplitudes from (a). (c) EPSC response triggered by a pre-synaptic spike (1 mV, 50 ms) loaded on G_1 .

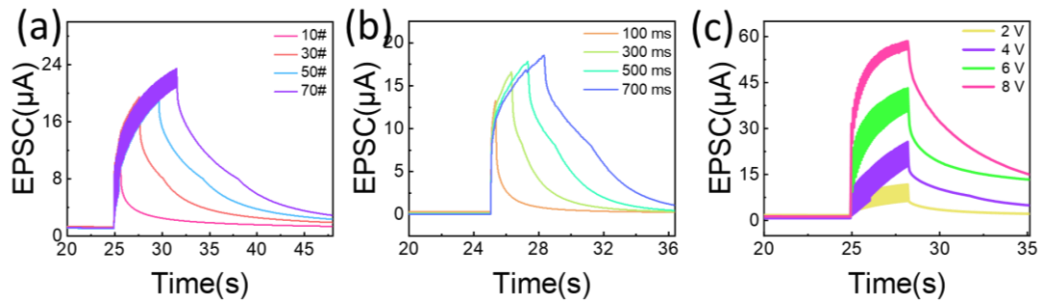


Fig. S5 (a) EPSC responses on gate spikes (5 V, 10 ms) with different numbers. The spike interval time (Δt) is 10 ms. (b) Spike duration dependent EPSC with spike amplitude of 5 V. (c) Spike amplitude dependent EPSC. The number of spikes, spike interval and duration time are 30, 10 ms, and 10 ms, respectively. EPSC is detected with constant V_{ds} of 1 V.

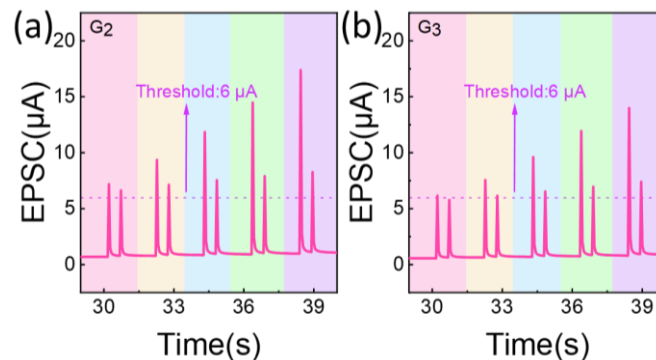


Fig. S6 EPSC responses on spikes in Fig. 6(f) loaded on (a) G_2 and (b) G_3 .

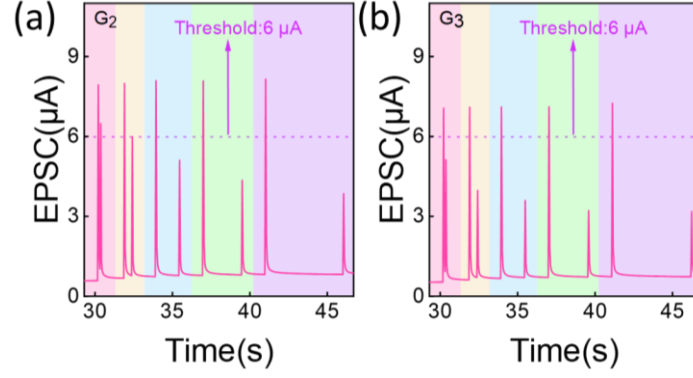


Fig. S7 EPSC responses on spikes in Fig. 6(j) loaded on (a) G_2 and (b) G_3 .

Table S1 Main electrical parameters for the reported neuromorphic transistors.

| Electrolyte | Operation voltage (V) | ΔV_{th} (V) | Ion/off | Ref. |
|------------------|-----------------------|---------------------|-------------------|-----------|
| EMIM:TFSI | 0.25 to -1.5 | / | $>10^4$ | [10] |
| PVDF-HFP | -3 to -4.5 | / | / | [11] |
| SiO ₂ | 50 to -50 | / | / | [12] |
| HfO ₂ | -2 to 2 | / | $>10^3$ | [13] |
| SiO ₂ | -0.5 to 1 | 0.1 | 4.4×10^5 | [14] |
| SiO ₂ | -0.5 to 1.5 | 0.1 | 2.6×10^6 | [15] |
| 10Sc1CeSZ | -1.5 to 1.5 | 0.3 | 3.0×10^5 | [16] |
| Chitosan | -1.0 to 1.0 | 0.3 | 3.1×10^6 | [17] |
| MSC | / | 0.2 | 4.7×10^6 | [18] |
| SA | -2 to 2 | 0.7 | 4.8×10^5 | This work |

Table S2 P values for synaptic transistors in reported works.

| Spike (V) | Substrate | Synaptic-transistor | P (fJ) | Ref. |
|-----------|-----------|--|----------|-----------|
| 0.1 | Si | In ₂ O ₃ NF _s | 15000 | [19] |
| 0.5 | Paper | IZO | 16000 | [20] |
| 10 | Glass | InGaAs | 0.84 | [21] |
| 10 | Si | PVDT-10 | 480 | [22] |
| 0.005 | Si | InSnMgO nanofibers | 1250 | [23] |
| 1 | Glass | IGZO | 6.984 | [24] |
| / | Si | InAlZnO nanofiber | 75 | [25] |
| 0.1 | Si | IGZO | 1080 | [26] |
| -0.2 | Si | HZO | 2 | [27] |
| 0.4 | P-Si | IGZO | 3800 | [28] |
| 0.001 | Glass | ITO | 0.59 | This work |

Table S3 The fitting parameters obtained in Fig. 6(i).

| Position | H_0 (%) | H_1 (%) | U_0 (V) |
|----------|-----------|-----------|-----------|
| G_1 | 72.4 | -896.7 | 0.82 |
| G_2 | 73.3 | -631.0 | 0.96 |
| G_3 | 88.9 | -347.5 | 1.52 |
| G_4 | 147.2 | -255.2 | 3.73 |

Table S4 The fitting parameters obtained in Fig. 6(m).

| Position | E_1 (%) | E_0 (%) | τ (ms) |
|----------------|-----------|-----------|-------------|
| G ₁ | 41.8 | 46.6 | 395.2 |
| G ₂ | 40.1 | 42.3 | 365.9 |
| G ₃ | 40.0 | 33.9 | 142.8 |
| G ₄ | 31.5 | 35.6 | 96.8 |

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