# Supporting Information

## Multimode Adaptive Logic Gates Based on Temperature-Responsive DNA Strand Displacement

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## Data processing

The fluorescence intensity for fluorophore FAM depended on temperature, which necessitated the normalization of the signal to obtain melting curves (Fig. S1). The signals from all the samples were subtracted by the negative control signal to account for the background signal. The signal data were then normalized by dividing the value by the positive control sample. Further normalization was performed by subtracting the minimum signal and dividing the resulting value by the maximum value in the data set to obtain the melting curve.

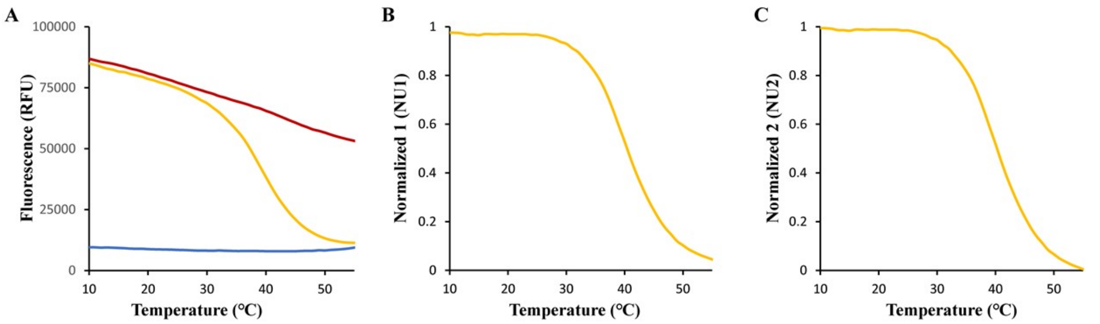


**Fig. S1.** Normalization process of fluorescence signal for the state-switching system. (A) Raw data from the fluorescence experiment. The blue, red, and yellow curves represent the negative control, the positive control, and the experimental sample, respectively. (B) Background subtraction and normalization using negative and positive controls. (C) Further normalization using minimum and maximum values within the dataset.

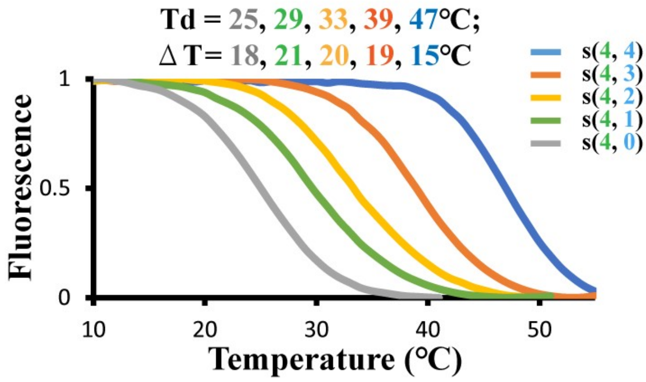


**Fig. S2.** The effect of toehold length on the temperature responses. s(i,j) = s(4,0), s(4,1), s(4,2), s(4,3), or s(4,4).

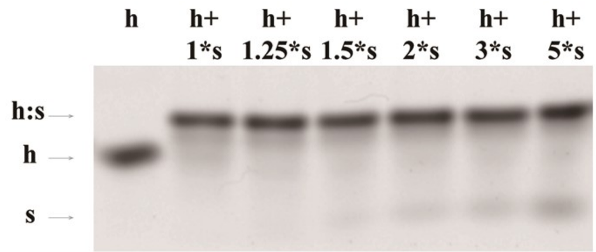


**Fig. S3** The gel electrophoresis image of nanosystem with hairpin h and different concentrations of invading strand s(3,4). Lane 1: DNA hairpin strand. Lane 2 to lane 7: DNA hairpin strand (1 uM) mixed with varied concentrations of invading strand s(3,4), 1 uM, 1.25 uM, 1.5 uM, 2 uM, 3 uM, and 5 uM, respectively.

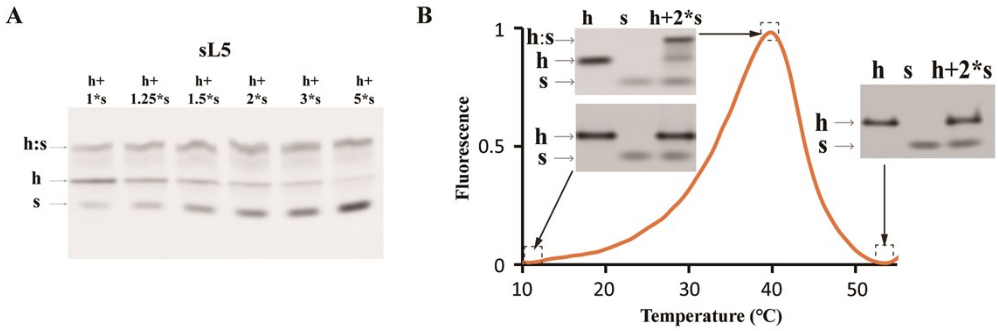


**Fig. S4** Native PAGE gel electrophoresis analysis of nanosystem with hairpin h and invading strand sL5. (A) The gel image of nanosystem with hairpin h and different concentrations of sL5. Lane 1 to lane 6: DNA hairpin strand (1 uM) mixed with varied concentrations of invading strand sL5, 1 uM, 1.25 uM, 1.5 uM, 2 uM, 3 uM, and 5 uM, respectively. (B) The gel image of the system with hairpin h (1 uM) and strand sL5 (2 uM). The gel electrophoresis run at 10 °C, 40 °C, and 55 °C, respectively.

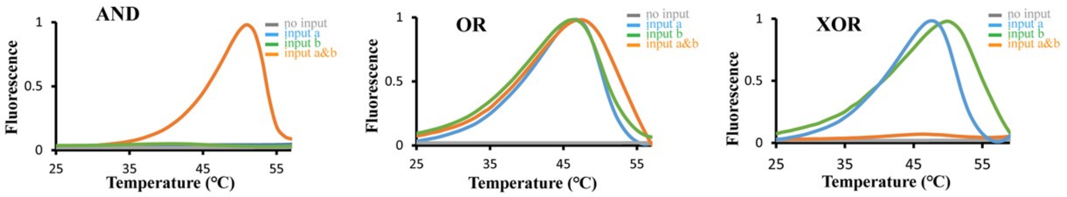


**Fig. S5.** The fluorescence melting curves of nanosystems performing logic gates AND, OR, and XOR.

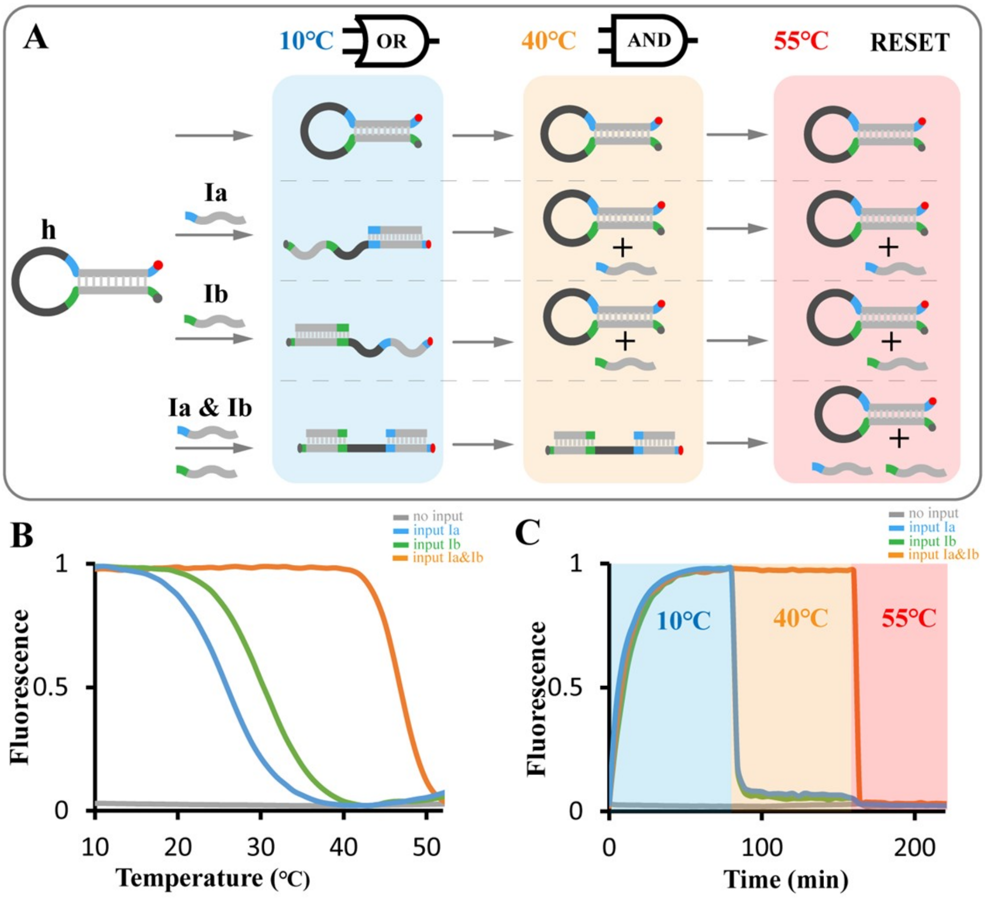


**Fig. S6.** Temperature-responsive three-state transition system that switched between two different logic gates (OR and AND). (A) Illustration of four states of the system. At 10 °C, the transition system performed OR function; at 40 °C, the system performed AND function; at 55 °C, the system was in RESET state. (B) The melting curves of the system. (C) Fluorescence curves of the system that transited among three states.

Table S1. Sequences of the Oligonucleotides (5’ to 3’)

| strand | | sequence |
|---|---|---|
| h | | FAM-GAATAGTGTAAGAGGAAGTTTTTTTTTATGGCTCTTACACTTCAC-BHQ1 |
| s0 | | CTTCCTCTTACACTATTC |
| s(4,4) | | CTTCCTCTTACACTATTC |
| s(4,3) | | CTTCCTCTTACACTATT |
| s(4,2) | | CTTCCTCTTACACTAT |
| s(4,1) | | CTTCCTCTTACACTA |
| s(4,0) | | CTTCCTCTTACACT |
| s(3,4) | | TTCCTCTTACACTATTC |
| s(3,3) | | TTCCTCTTACACTATT |
| s(2,4) | | TCCTCTTACACTATTC |
| s(1,4) | | CCTCTTACACTATTC |
| s(0,4) | | CTCTTACACTATTC |
| sL5 | | AATAGTTCCTCTTACACTATT |
| AND gate | input Ia | CTCTTACACTATTCAAGAG |
| | input Ib | AGTGTAAGAGCCATACACT |
| OR gate | input Ia | TTCCTCTTACACTATTAGGAA |
| | input Ib | CTTCCTCTTACACTGGAAG |
| XOR gate | input Ia | AATAGTTTCCTCTTACACTATTCGATTAGC |
| | input Ib | GCTAATCGTGAAGTGTAAGAGCCAACTTC |
| 4-state adaptive gate | input Ia | GCGTTCCTCTTACACTATT |
| | input Ib | AAGTGTAAGAGCCATCGC |
| 3-state adaptive gate | input Ia | CTCTTACACTATTC |
| | input Ib | GTGAAGTGTAAGAG |