Electronic Supplementary Material (ESI) for Nanoscale.

Electronic Supplementary Information

Information processing using an integrated DNA reaction network

Dan Huang, Huayi Han, Chen Guo, Xiao Lin, Die Chen, Shu Yang, Qianfan Yang,* Feng Li*

Table of Contents

1. Oligonucleotide sequences used in this work.

Table S1. The oligonucleotide sequences used in this work.

Name	Sequence from 5' to 3'
A1	AGC CAG CTG AGC CAA TTC ATG GAC CAG AAC AAC C
A1*	GGT CGT TCT GGT CCA TGA ATT GGC TCA GCT GGC T
CBc2	TGA GCC AAT TCA TGG ACC AGA ACA ACC TGA CGC TCC TAG CTT CAC TGA CTC ACT CTA CT
Bc2	CAG TAG AGT GAG TCA GTG AAG TCA GTG CTA GGA GCG TCA
WBc2	TGA GTC AGT GAA GCT AGG AGC GTC AGG TTG T
CBa3'	TGA GCC AAT TCA TGG ACC AGA ACA ACC ATC AAA ATA TGT GAA TTT TTA CTA CCC AAG AA
Ba3'	CAT GGC CTT CTT GGG TAG TAA AAA TTT CAG CTC ACA TAT TTT GAT
WBa3'	GGT AGT AAA AAT TCA CAT ATT TTG ATG GTT GT
CBa3'	TGA GCC AAT TCA TGG ACC AGA ACA ACC ATC AAA ATA TGT GAA TTT TTA CTA CCC AAG AA
A2	CCTTAGCAGAGCTGTGGAGTGTGACAATGGTGTT
A2*	AAC ACC ATT GTC ACA CTC CAC AGC TCT GCT AAG G
CBa1*	CCT TCT TGG GTA GTA AGA GAG TTG CCC TCC TTA GCA GAG CTG TGG AGT GTG ACA AT
WBa1*	GCT AAG GAG GGC AAC TCT CTT ACT ACC CAA G
Ba1*	AGG GCA ACT CTC CTT TTT TTT ACT ACC CAA GAA GGC C
CBf2'	CAG AGC TGT GGA GTG TGA CAA TGG TGT TGC AAC CGC AGC TAG GAT AGA AGT TGC CCA A
WBf2'	ACT TCT ATC CTA GCT GCG GTT GCA ACA CC
Bf2	TTG GGC AAC TTC TAT CCT TTG GCA GCT GCG GTT GC
CBm2	CAG AGC TGT GGA GTG TGA CAA TGG TGT TTG ACG CTC CTA GCT TCA CTG ACT CAC TCT AC
WBm2	GAG TCA GTG AAG CTA GGA GCG TCA AAC ACC
A3	TTG TTC CAC TTA TTT TAA TAG TTG TAG TTG TCG G
A3*	CCG ACA ACT ACA ACT ATT AAA ATA AGT GGA ACA A
CBc1	CAC TTA TTT TAA TAG TTG TAG TTG TCG GGA GTG ACA CTG TAG TCA GTG CTA GGA GGT TC
Bc1	TGA ACC TCC TAG CAC TGA CTT CAC TGA CAG TGT CAC TC
WBc1	CCT AGC ACT GAC TAC AGT GTC ACT CCC GAC A
CBf1	CAC TTA TTT TAA TAG TTG TAG TTG TCG GAG GGC AAC TCT CGC ATT TCA GCT CAA ATA TT
Bf1	ATC AAA TAT TTG AGC TGA AAT GCC AAA GGA GAG TTG CCC T
WBf1	TGA GCT GAA ATG CGA GAG TTG CCC TCC GAC A
OR1	ACC TAC CAA AAC ACT CCT CCT AAA ACA CCT CAC CCA
COR1	TGG GTG AGG TGT TTT AGG GTT TTG GTA GGT TTG TTC CAC TTA TTT TAA TAG TTG TAG
WOR1	GAA CAA ACC TAC CAA AAC CCT AAA ACA CC
B1d	TGAACCTCCTAGCACTGGAGACTACGTCTCAG
B2d	CAGTAGAGTGAGTCAGTGAGTACTGACGTA
A4	ACT CTT TGG CAA CGA CCC CTC GTC ACA ATA AAG A

A4*	TCT TTA TTG TGA CGA GGG GTC GTT GCC AAA GAG T
CBc2	GCA ACG ACC CCT CGT CAC AAT AAA GAT GAC GCT CCT AGC TTC ACT GAC TCA CTC TAC T
Bc2	CAG TAG AGT GAG TCA GTG AAG TCA GTG CTA GGA GCG TCA
WBc2	GTG AGT CAG TGA AGC TAG GAG CGT CAT CTT TA
CBa1'	GCA ACG ACC CCT CGT CAC AAT AAA GAA GGG CAA CTC TCG CAT TTC AGC TCA AAT ATT TG
Ba1'	ATC AAA TAT TTG AGC TGA AAT GCC AAA GGA GAG TTG CCC T
WBa1'	TTT GAG CTG AAA TGC GAG AGT TGC CCT TCT TTA
CBa2	GCA ACG ACC CCT CGT CAC AAT AAA GAG ACA TTG TCA GTT TTT TAA AGG AGA GTT GCC C
Ba2	GGG CAA CTC TCC TTT AAA AAG GAG AGA CTG ACA ATG TC
WBa2	TCT CCT TTA AAA AAC TGA CAA TGT CTC TTT A
OR2	CTC AAT CTA TCA CCT ACC AAA ACA CTC CTC CTA AA
COR2	GCA ACG ACC CCT CGT CAC AAT AAA GAT TTA GGA GGA GTG GTA GGT GAT AGA TTG AG
WOR2	ATC ACC TAC CAC TCC TCC TAA ATC TTT A
MBBa1*	ROX-GCA ACT CAA AAA AGG AGA GTT GC-BHQ2
Sa	CAG GTG ACA TTG TCA GTC TCT CCA CTA CCC AAG AAG GC
Fa	GGG TGG GTA GTG GAG AGA CTG ACA A
Qaa	CAG GTG ACA TTG TCA GTC TCT CCA CTA CCC AAG AAG G
Saa	GGG TGG GTA GTG GAG AGA CTG ACA A
MBBc1	ROX-TCA GTG CTA GGA GGT GCA CTG A-BHQ2
HBc2	AGT GAA GTG GGC AGA GGG GTG GGT TGG GCT CTG ACT TCA CTG ACT CAC
HF1	CCA AAG GAG AGT GGG TTG GGT TGG GAA CTC TCC TTT GGC
HF2	CAA AGG ATA GAA GTT GCC CAA GGG TGG GTG GGT GGG CAA CTT CT
HF3	TTT CAG CTC AAA TAT TTG ATT ATT CCC TTC CCT TCC CAA TAA CCC AAA TAT TTG AG
Fo	Dabcyl-AGG AGT GTT TTG GTA GGT
So	CAA AAC ACT CCT-6-FAM
L-Sa	CAG GTG ACA dT(BHQ2)TG TCA GTC TCT CCA CTA CCC AAG AAG GC
L-Fa	GGG TGG GTA GTG GAG AGA CTG ACA A-ROX
A3-3	TGCTCTTTCTGCATTCCTGG
A3-5	TGGTGTTTCTGCATTCCTGG
A3-8	TGGTCTTACTGCATTCCTGG
A3-10	TGGTCTTTCTCCATTCCTGG

2. The scheme and PAGE results of the one-to-one translation.

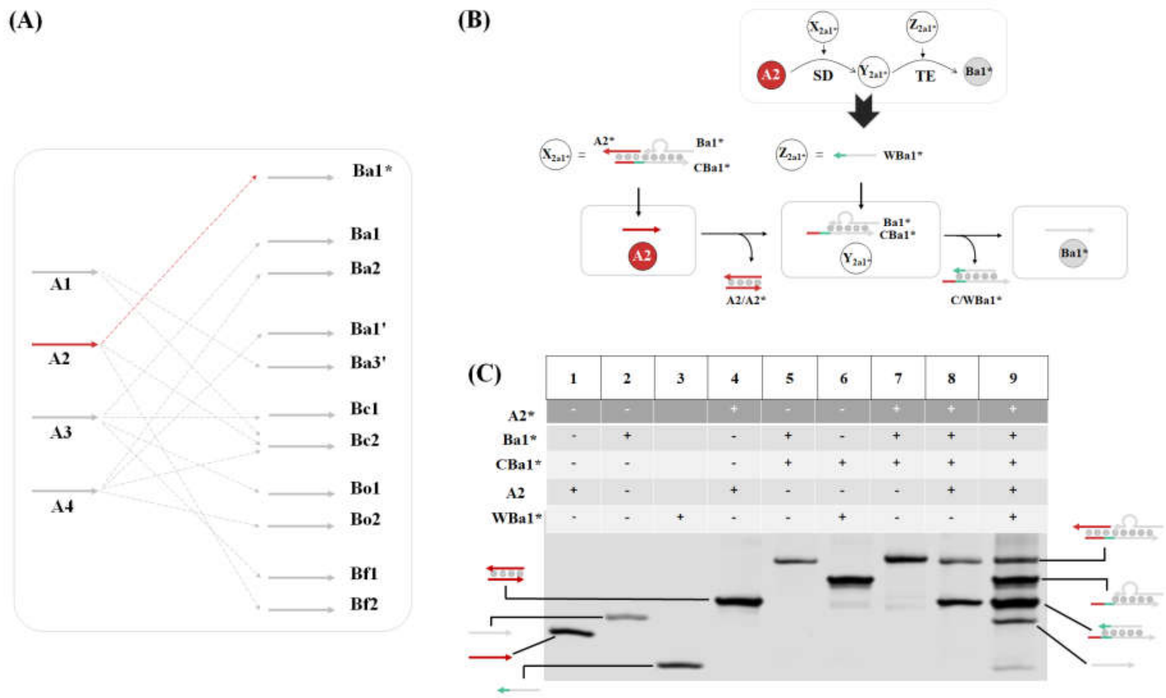

Figure S1. The ***A2***-to-***Ba1**** translation. (A) The diagram of ***A2***-to-***Ba1**** in translation module. (B) The abstract description and scheme of ***A2***-to-***Ba1**** translation by cascading two-step DNA strand displacement reaction. (C) The PAGE results of the translation of ***A2***-to-***Ba1****.

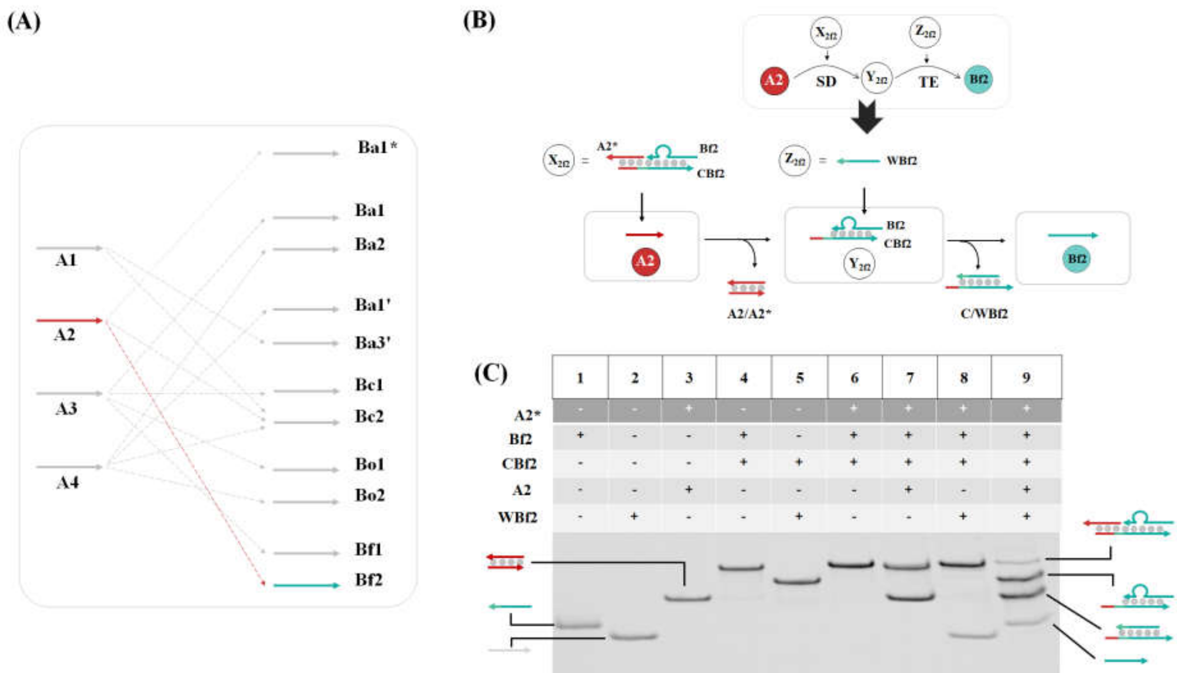

Figure S2. The ***A2***-to-***Bf2*** translation. (A) The diagram of ***A2***-to-***Bf2*** in translation module. (B) The abstract description and scheme of ***A2***-to-***Bf2*** translation by cascading two-step DNA strand displacement reaction. (C) The PAGE results of the translation of ***A2***-to-***Bf2***.

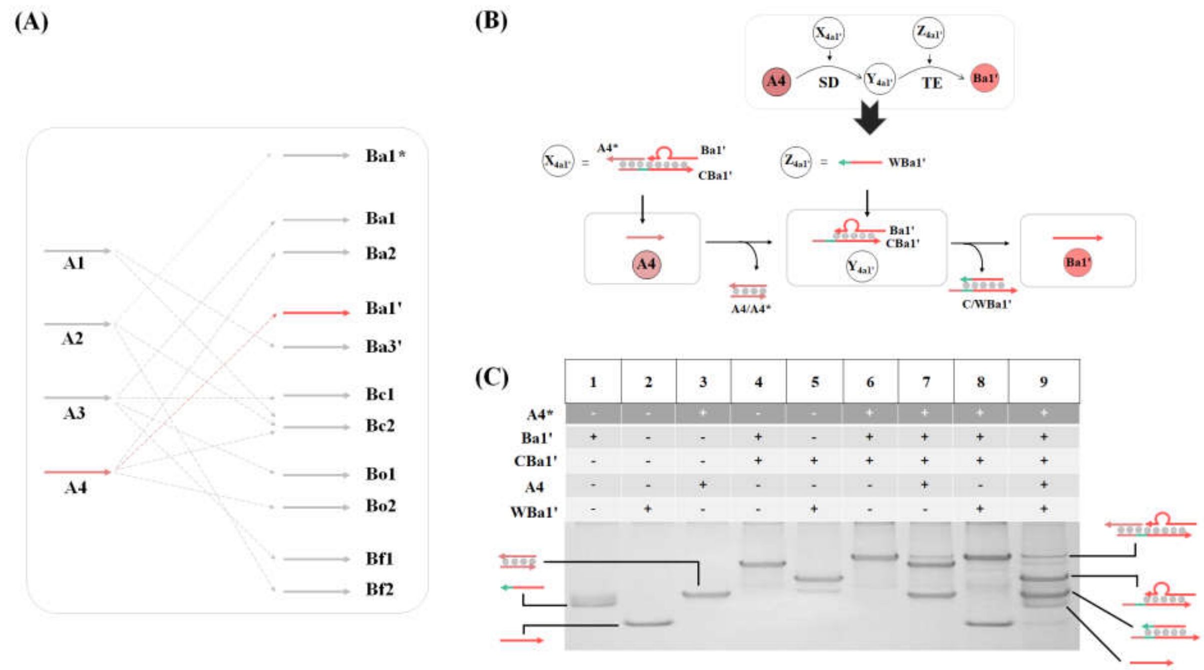

Figure S3. The ***A4***-to-***Ba1'*** translation. (A) The diagram of ***A4***-to-***Ba1'*** in translation module. (B) The abstract description and scheme of ***A4***-to-***Ba1'*** translation by cascading two-step DNA strand displacement reaction. (C) The PAGE results of the translation of ***A4***-to-***Ba1'***.

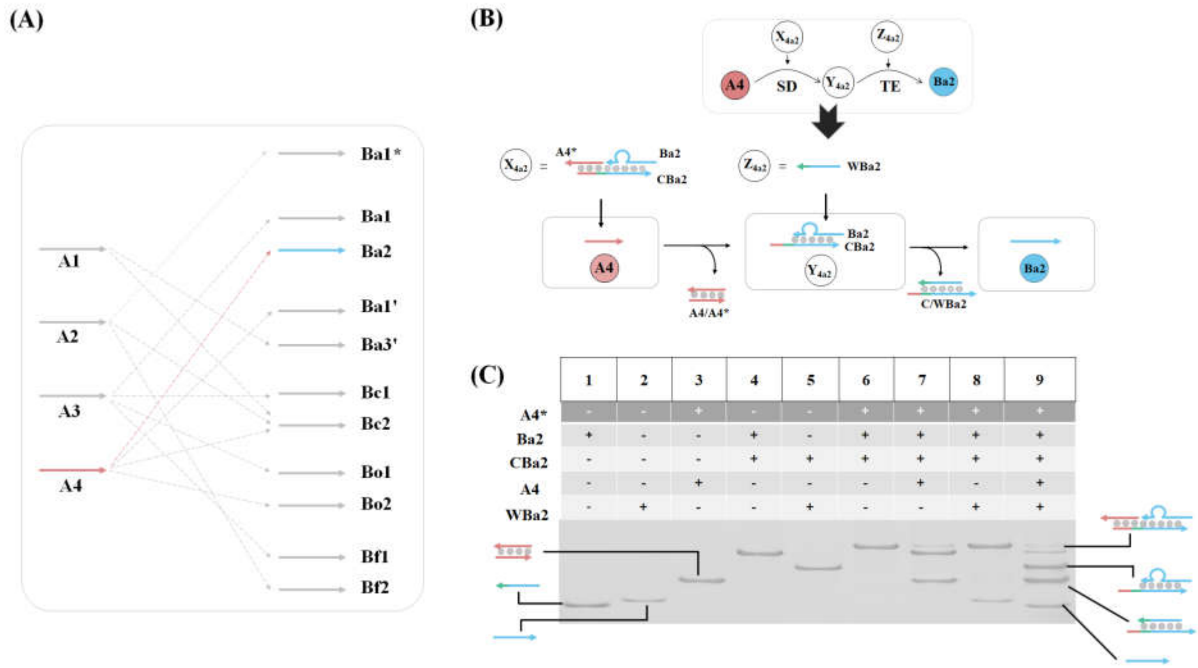

Figure S4. The ***A4***-to-***Ba2*** translation. (A) The diagram of ***A4***-to-***Ba1'*** in translation module. (B) The abstract description and scheme of ***A4***-to-***Ba2*** translation by cascading two-step DNA strand displacement reaction. (C) The PAGE results of the translation of ***A4***-to-***Ba2***.

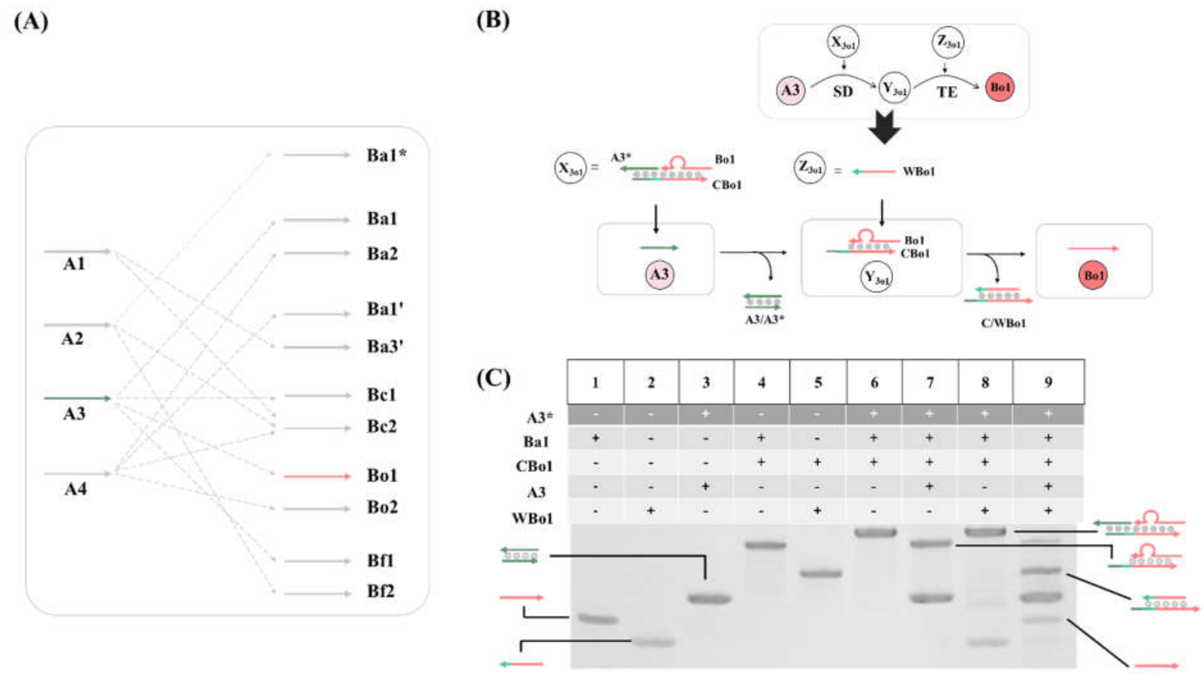

Figure S5. The ***A3***-to-***Bo1*** translation. (A) The diagram of ***A3***-to-***Bo1*** in translation module. (B) The abstract description and scheme of ***A3***-to-***Bo1*** translation by cascading two-step DNA strand displacement reaction. (C) The PAGE results of the translation of ***A3***-to-***Bo1***.

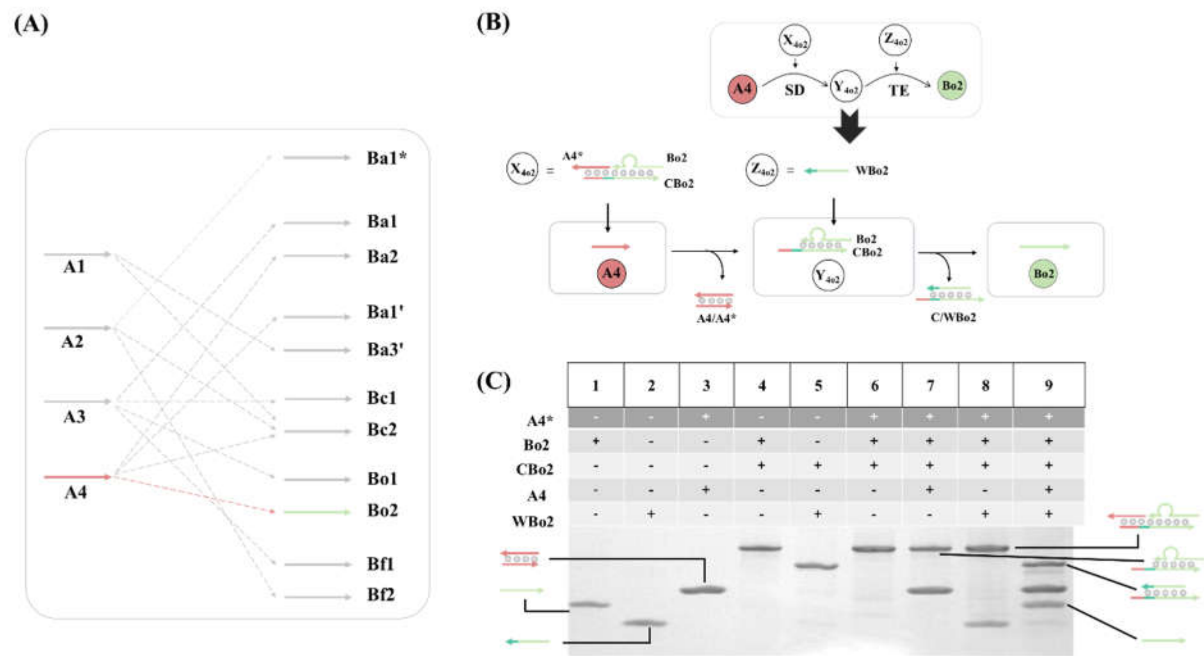

Figure S6. The ***A4***-to-***Bo2*** translation. (A) The diagram of ***A4***-to-***Bo2*** in translation module. (B) The abstract description and scheme of ***A4***-to-***Bo2*** translation by cascading two-step DNA strand displacement reaction. (C) The PAGE results of the translation of ***A4***-to-***Bo2***.

3. The scheme of one-to-many and many-to-one translation.

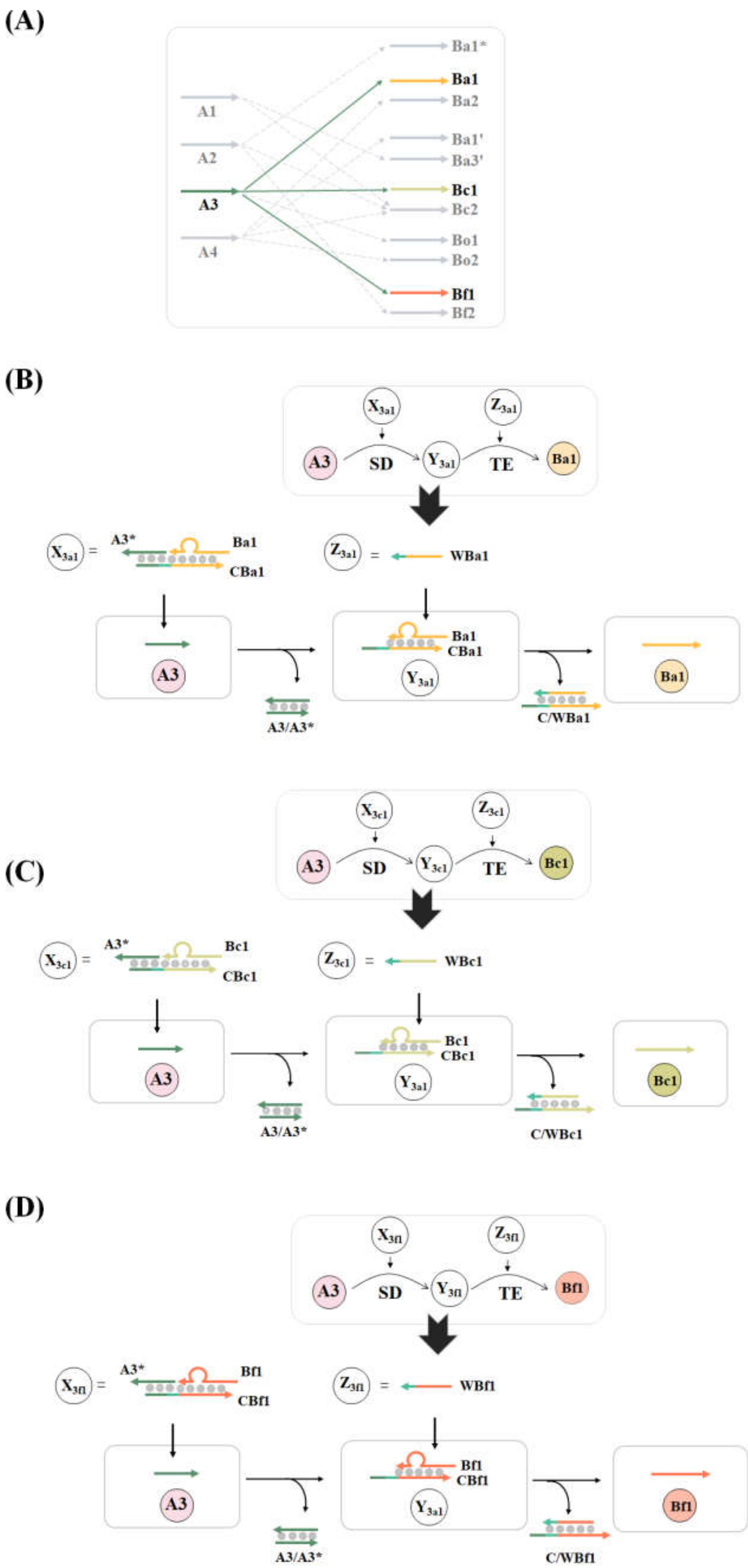

Figure S7. The scheme of one-to-many. (A) The diagram of ***A3***-to-***Ba1/Bc1/Bf1*** in translation module. (B) The abstract description and scheme of ***A4***-to-***Ba1*** translation. (C) The abstract description and scheme of ***A4***-to-***Bc1*** translation. (D) The abstract description and scheme of ***A4***-to-***Bf1*** translation.

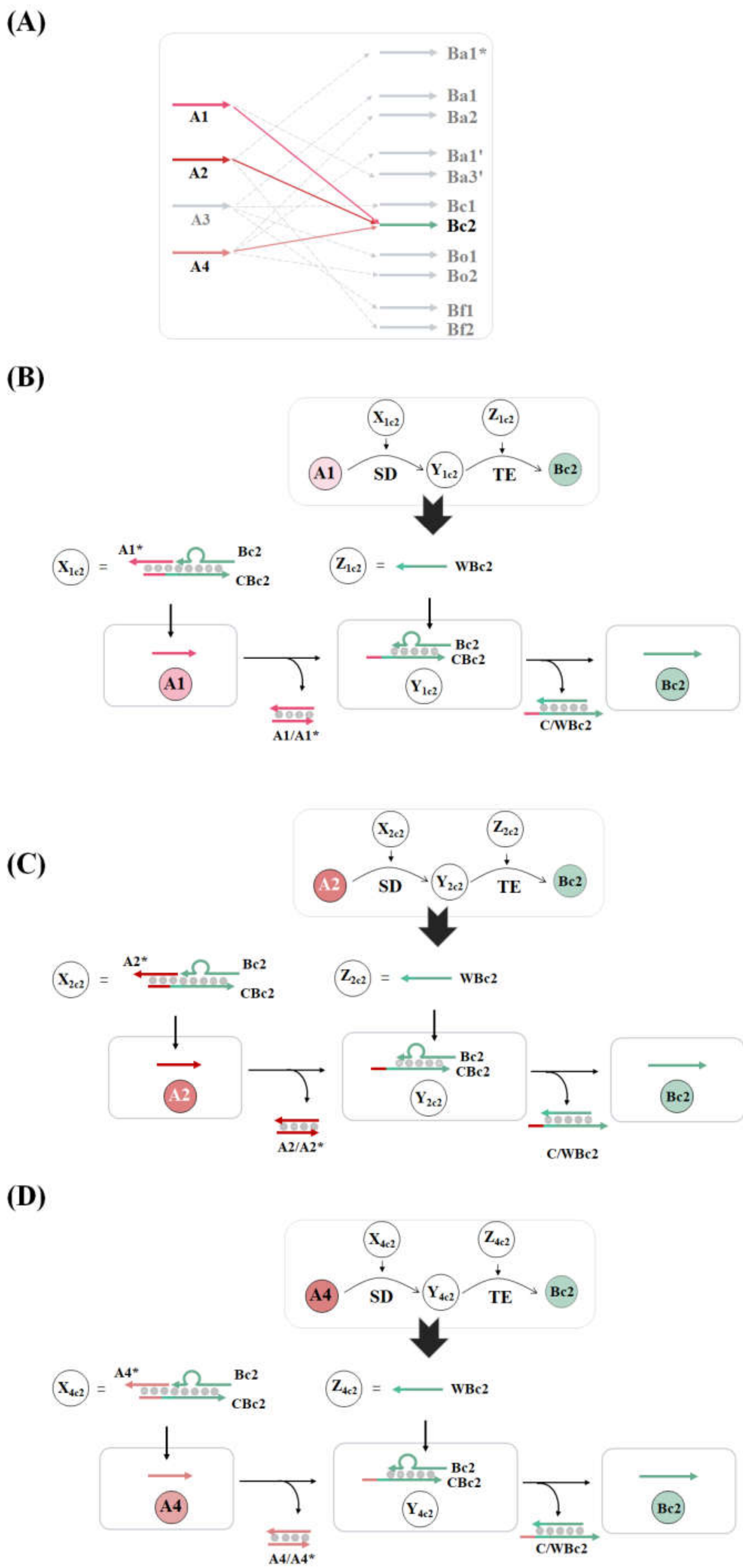

Figure S8. The scheme of many-to-one. (A) The diagram of ***A1/A2/A4*-to-*Bc2*** in translation module. (B) The abstract description and scheme of ***A1*-to-*Bc2*** translation. (C) The abstract description and scheme of ***A2*-to-*Bc2*** translation. (D) The abstract description and scheme of ***A4*-to-*Bc2*** translation.

4. AND gate.

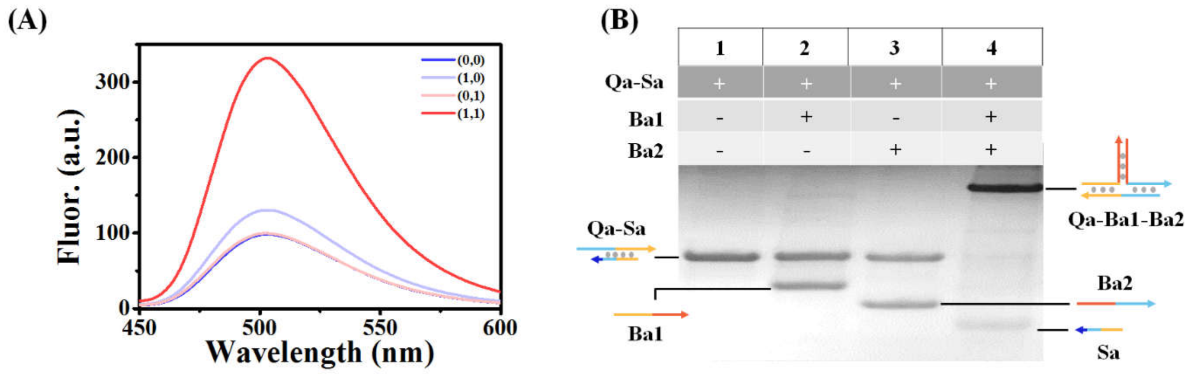

Figure S9. The original fluorescence spectrum and PAGE results of the AND gate, and the G-quadruplex fluorescent probe Thioflavin T (ThT) was employed to generate output signals.

5. The YES gate.

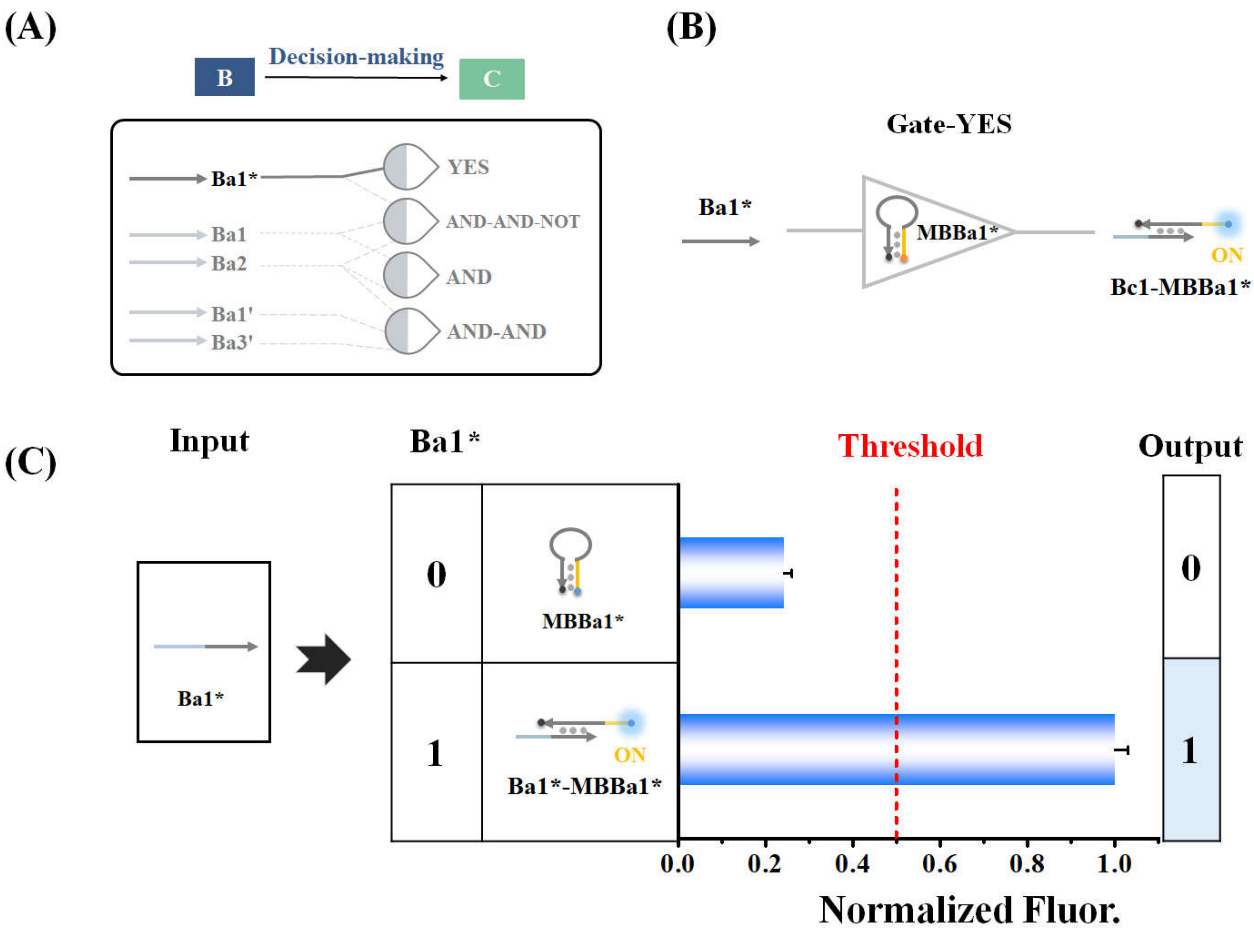

Figure S10. The YES gate. (A) The abstract diagram of YES gate. (B) The logic circuit and signal generation mechanism of YES gate. (C) Schematic and normalized fluorescence results of YES gate.

6. The Comparator gate.

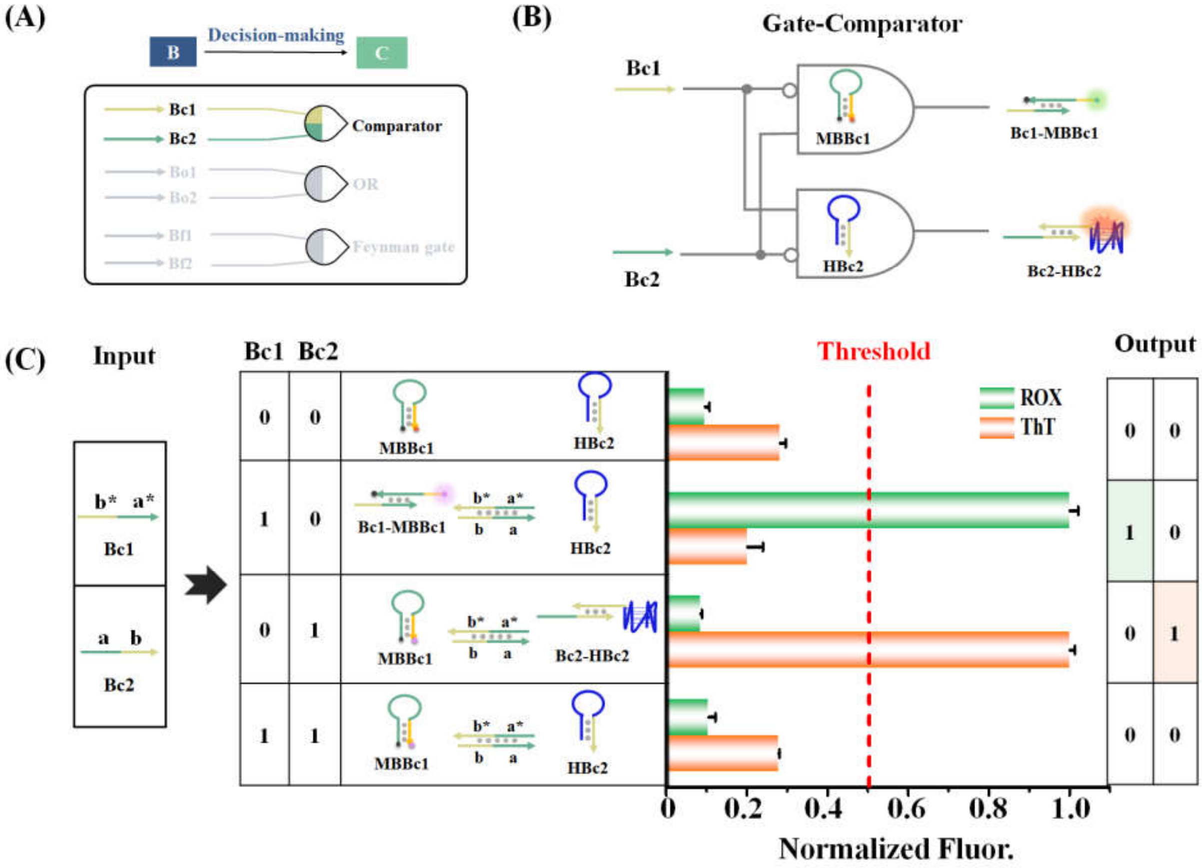

Figure S11. The Comparator gate. (A) The abstract diagram of the Comparator gate. (B) The logic circuit and signal generation mechanism of the Comparator gate. (C) Schematic and normalized fluorescence results of the Comparator gate.

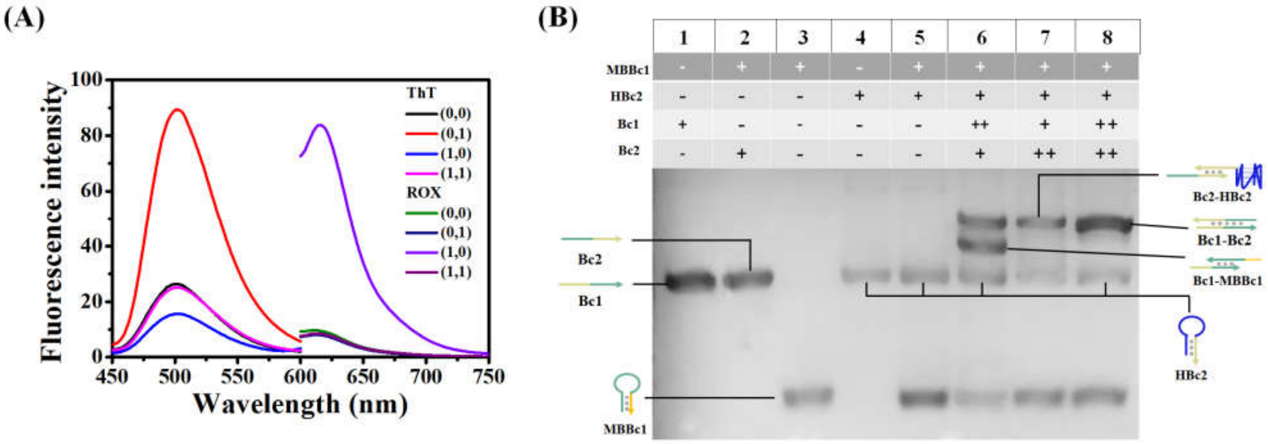

Figure S12. The original fluorescence spectrum (A) and PAGE results (B) of the Comparator gate.

7. The OR gate.

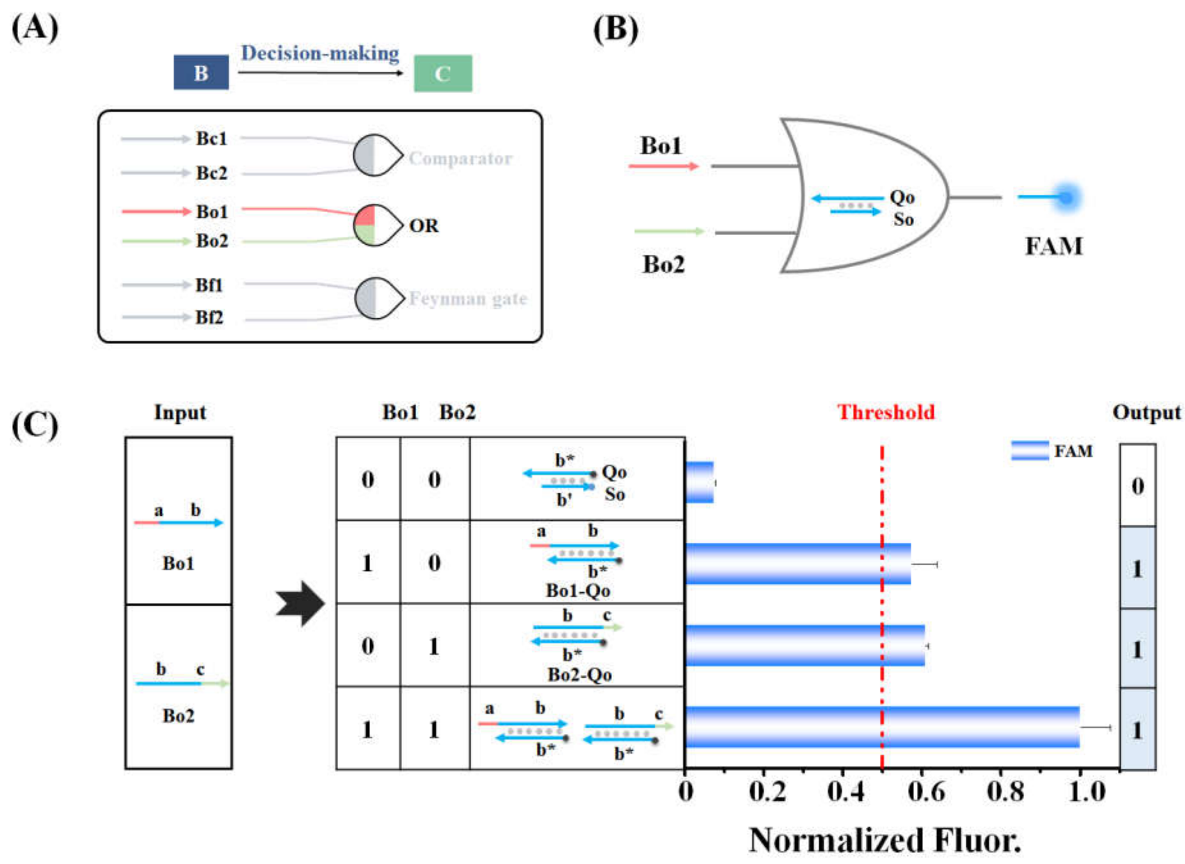

Figure S13. The OR gate. (A) The abstract diagram of the OR gate. (B) The logic circuit and signal generation mechanism of the OR gate. (C) Schematic and normalized fluorescence results of the OR gate.

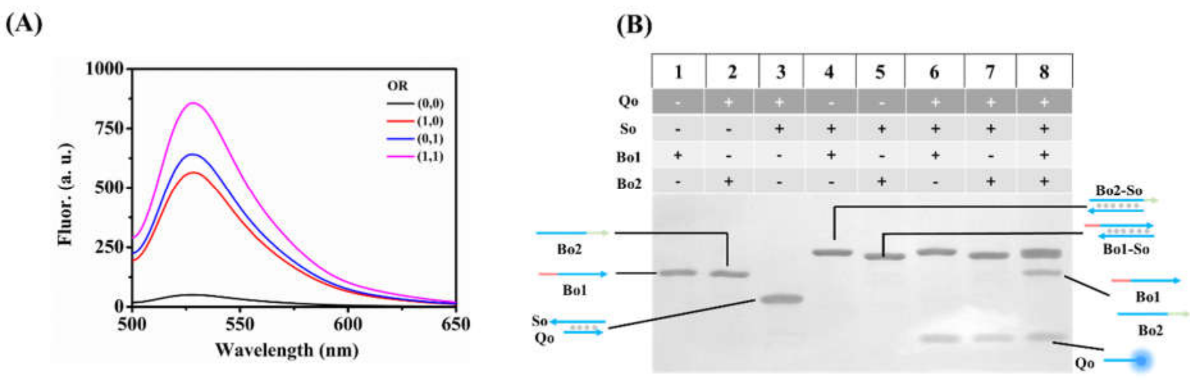

Figure S14. The original fluorescence spectrum and PAGE results of the OR gate.

8. The Feynman gate.

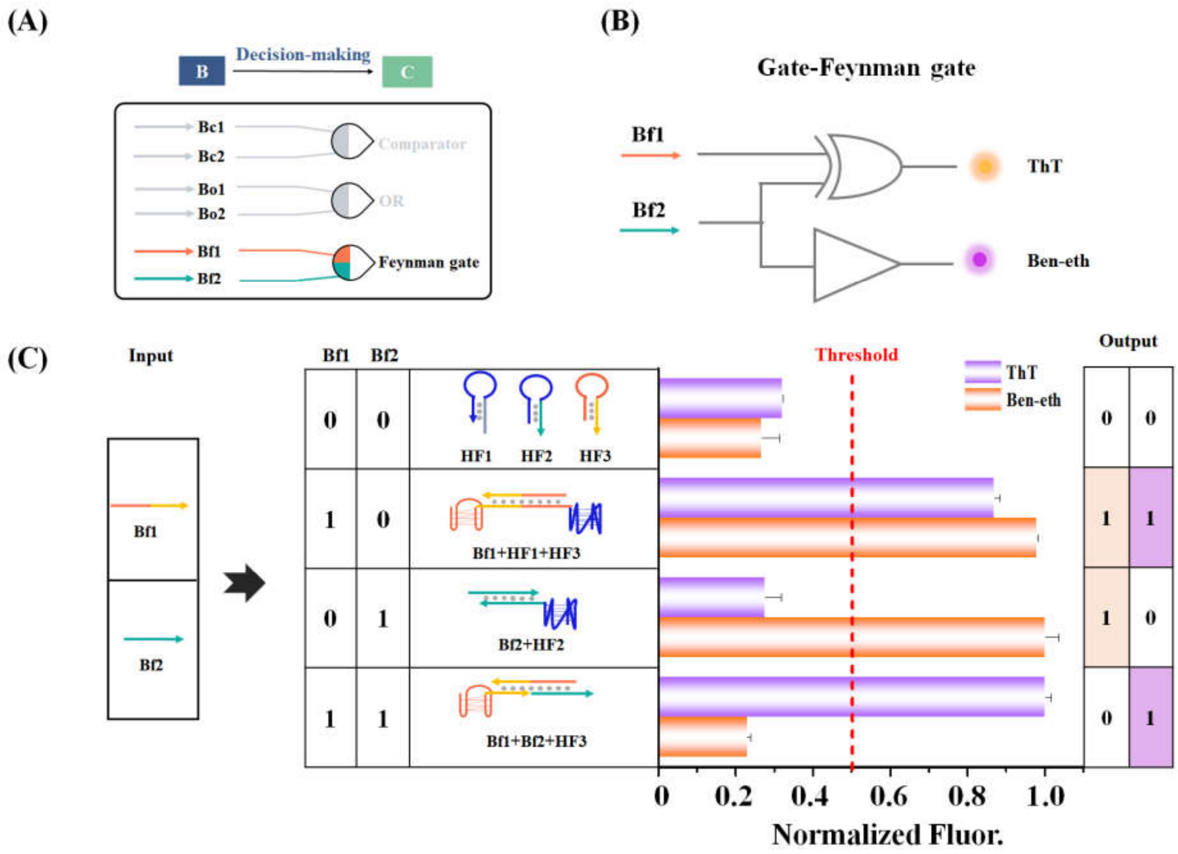

Figure S15. The Feynman gate. (A) The abstract diagram of the Feynman gate. (B) The logic circuit and signal generation mechanism of the Feynman gate. (C) Schematic and normalized fluorescence results of the Feynman gate.

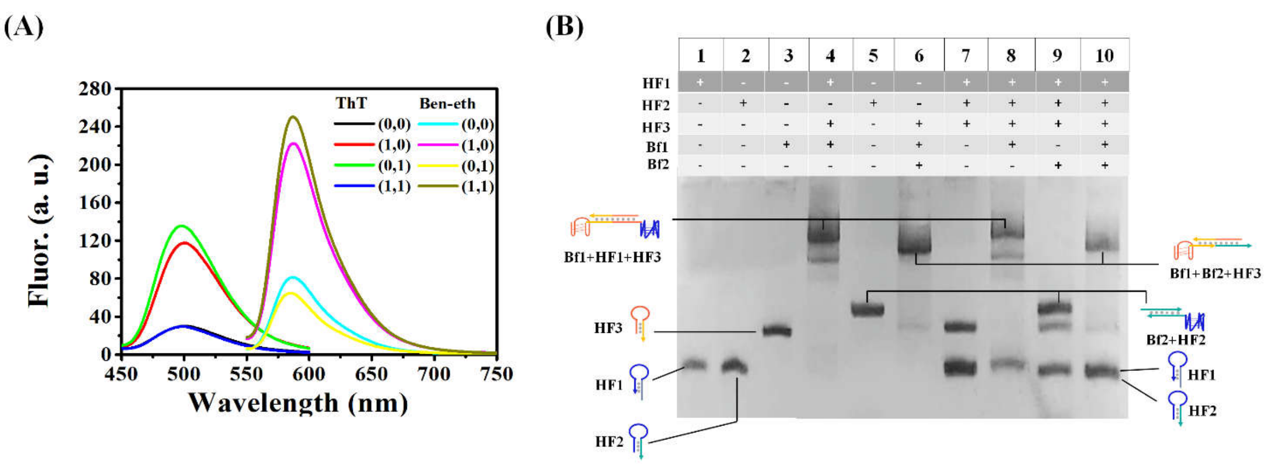

Figure S16. The original fluorescence spectrum (A) and PAGE results (B) of the Feynman gate.

9. The PAGE results and fluorescence spectrum of AND-AND gate.

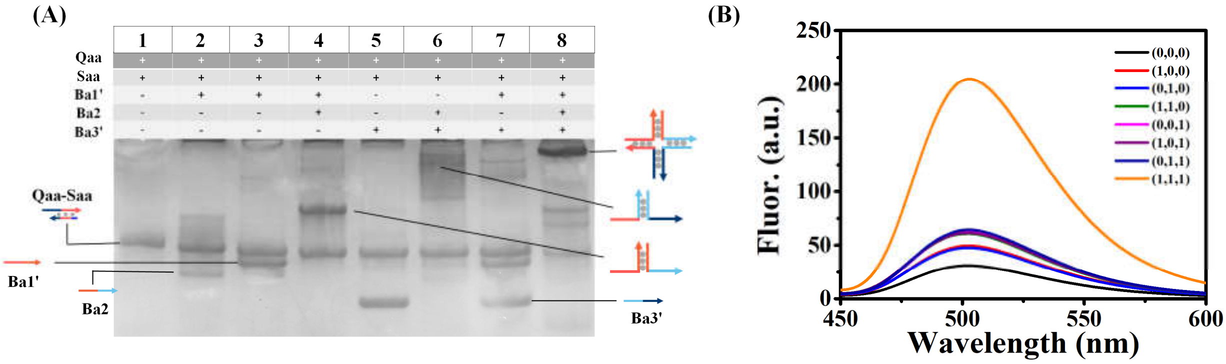

Figure S17. The PAGE results (A) and original fluorescence spectrum (B) of the AND-AND gate.

10. The PAGE results and fluorescence spectrum of AND-AND-NOT gate.

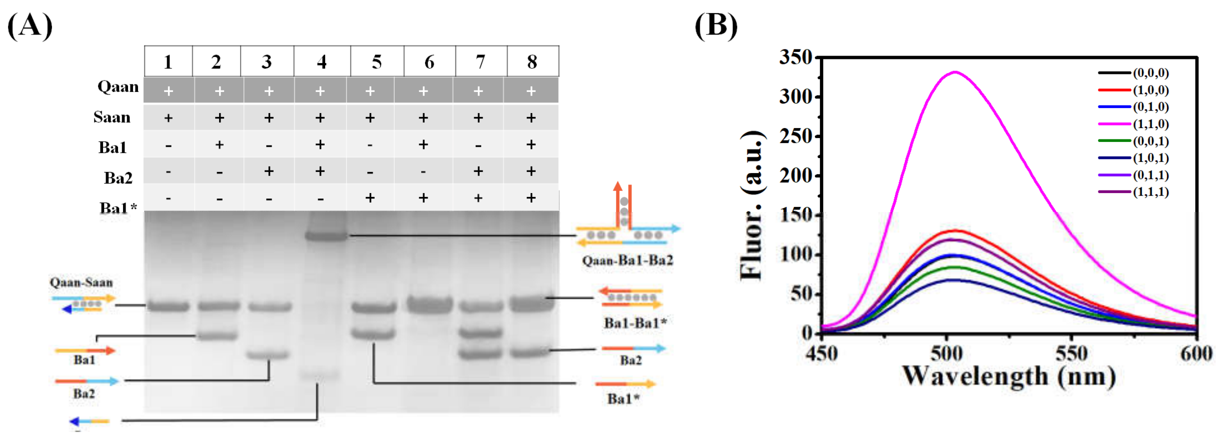

Figure S18. The PAGE results (A) and original fluorescence spectrum (B) of the AND-AND-NOT gate.

11. The original fluorescence spectrum of cascaded AND and OR gate.

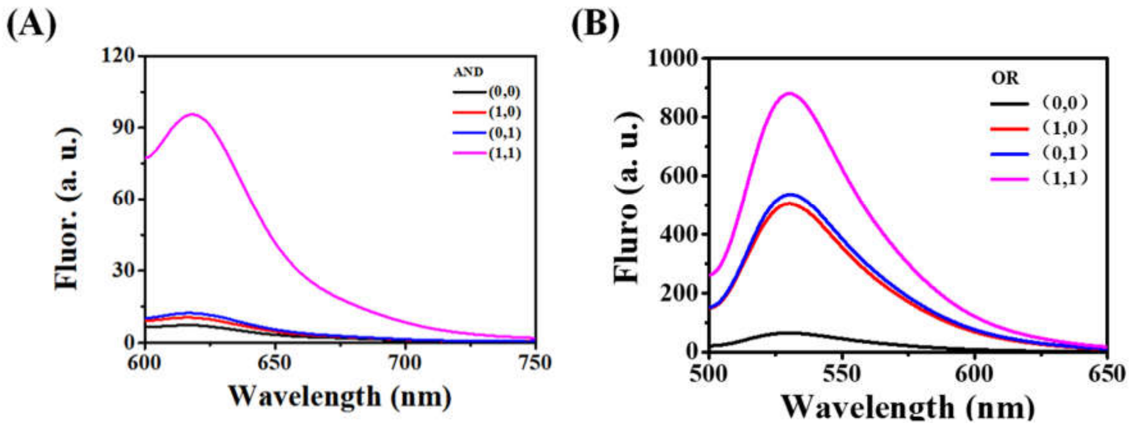

Figure S19. The original fluorescence spectrum of cascaded AND (A) and OR gate (B).

12. The influence of the translation process upon adding different targets.

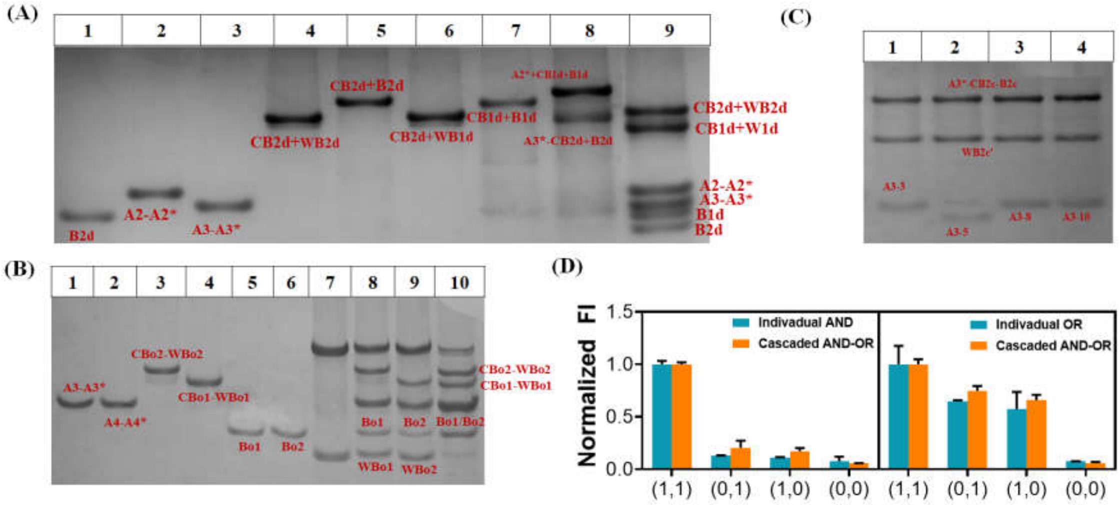

Figure 20 The PAGE result of the parallel translation from **A2** to **B1d** and **A3** to **B2d** (A); lane 1: **B2d**, lane 2: **A2+A2***, lane 3: **A3+A3***, lane 4: **CB2d +WB2d**, lane 5: **CB2d+B2d**, lane 6: **CB1d+WB1d**, lane 7: **CB1d+B1d**, lane 8: **A2*+CB1d+B1d+A3* +CB2d+B2d**, lane 9: **A2*+CB1d+B1d+A3*+CB2d+B2d+A2+A3**. And the parallel translation from **A3** to **Bo1** and **A4** to **Bo2** (B); lane 1: **A3+A3***, lane 2: **A4+A4***, lane 3: **CBo2+WBo2**, lane 4: **CBo1+WBo1**, lane 5: **Bo1**, lane 6: **Bo2**, lane 7: **A3*+CBo1 +Bo1+A4*+CBo2+Bo2+WBo1+WBo2**, lane 8: **A3*+CBo1+Bo1+A4*+CBo2+Bo2 +WBo1+WBo2+A3**, lane 9: **A3*+CBo1+Bo1+A4*+CBo2+Bo2+WBo1+WBo2+A4**; lane 10: **A3*+CBo1+Bo1+A4*+CBo2+Bo2+WBo1+WBo2+A3+A4**. (C) The influence of single mutation at different location on the translation process; lane 1: **A3*+B2c+CB2c+WB2c+A3-3**, lane 2: **A3*+B2c+CB2c+WB2c+A3-5**, lane 3: **A3*+B2c+CB2c+WB2c+A3-8**, lane 4: **A3*+B2c+ CB2c+WB2c+A3-10**. **X** of **A3-x** represents the mutation location. (D) The comparison of fluorescence results individual **AND** and **OR** (blue green) and **AND-OR** cascade in parallel (orange).