Electronic Supplementary Material (ESI) for Analytical Methods.

Supplementary Information

Aptamer-based kinetically-controlled DNA reactions coupled with metal-organic framework nanoprobes for sensitive detection of SARS-CoV-2 spike protein

Yan Liu,[a] Yuanlin Zhou,[a] Wanting Xu,[a] Jiarong Li,[b] Shuning Wang,[c] Xiaojia Shen,[a] Xiaobin Wen[a] and Li Liu[a,*]

[a] Department of Pediatrics, Chengdu Second People's Hospital, Chengdu 610021, Sichuan, China

[b] College of Clinical Medicine, Southwest Medical University, Luzhou 646000, Sichuan, China

[c] School of Life Sciences, Shanghai University, Shanghai 200444, China

[*] Corresponding author. E-mail: excellent2120@163.com.

Table S1 Sequences of DNA probes used in this work

DNA probe	Sequence (from 5' to 3')
AP	CTTGATCAGGATAAGTTCAAGGCGGGTTCCTAGACTTGTACTCAGCCT CTGTTGCAACTGTA
BHQ-AP	CTTGATCAGGAT(BHQ)AAGTTCAAGGCGGGTTCCTAGACTTGTACTCA GCCTCTGTTGCAACTGTA
Random DNA	CTTGATCAGGATAAGTTCAGTGGAAGTTGGACGGGATTGCCTGTTGCA ACTGTA
SP	CTTATCCTGATCAAGCTCACAG
Biotin-SP	CTTATCCTGATCAAGCTCACAG-biotin
FAM-SP	FAM-CTTATCCTGATCAAGCTCACAG
FAM-SP-biotin	FAM-CTTATCCTGATCAAGCTCACAG-biotin
TP	TACAGTTGCTTTCTTATCCTGATCA
rTP	TTGCTGCTGCTTGACACATTAATGC
F-DNA	FAM-CTTGATCAGGATAAG

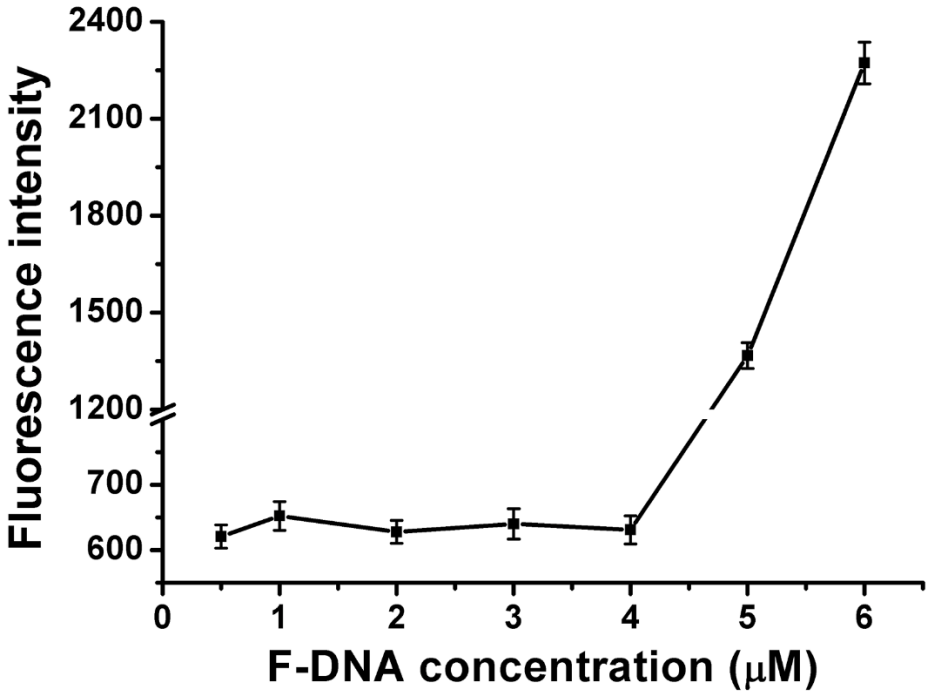

Fig. S1 Fluorescence responses obtained after incubating 50 μL of UiO-66-NH_2 with 50 μL of different concentrations of F-DNA.

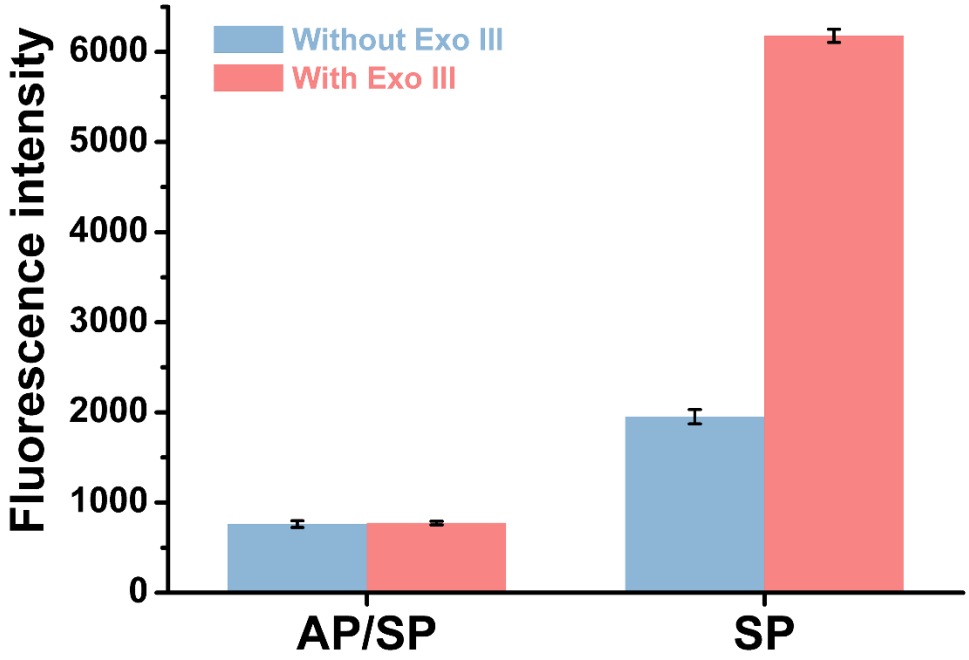

Fig. S2 Fluorescence responses of F-DNA@MOF after incubation with AP/SP or SP in the absence and presence of Exo III.

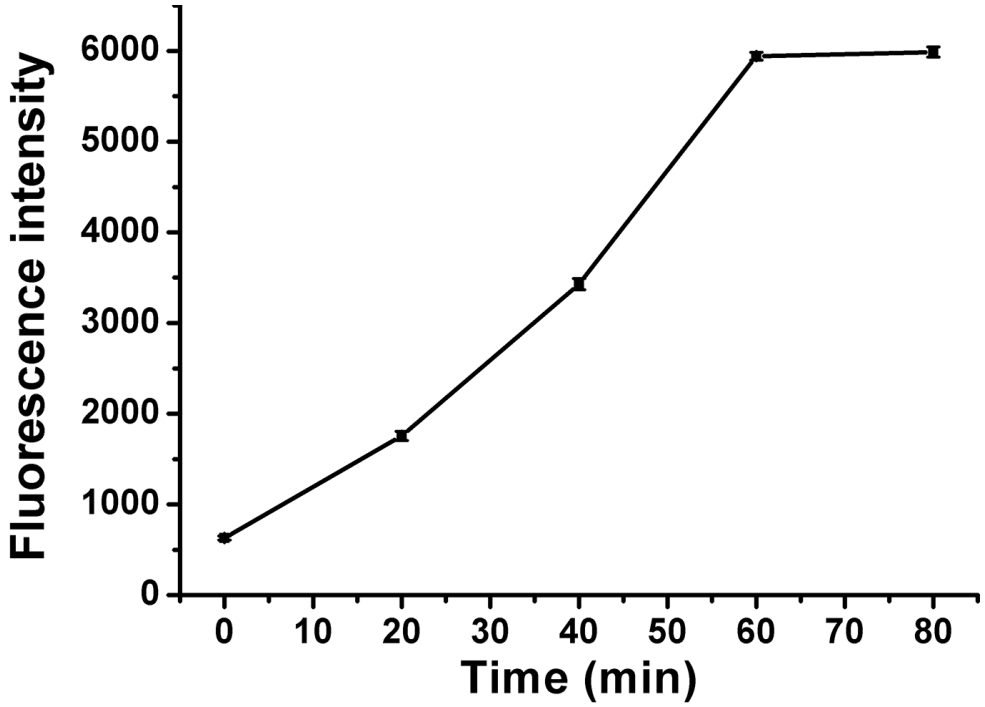

Fig. S3 Optimization of the reaction time for aptamer-based kinetically-controlled DNA displacement.

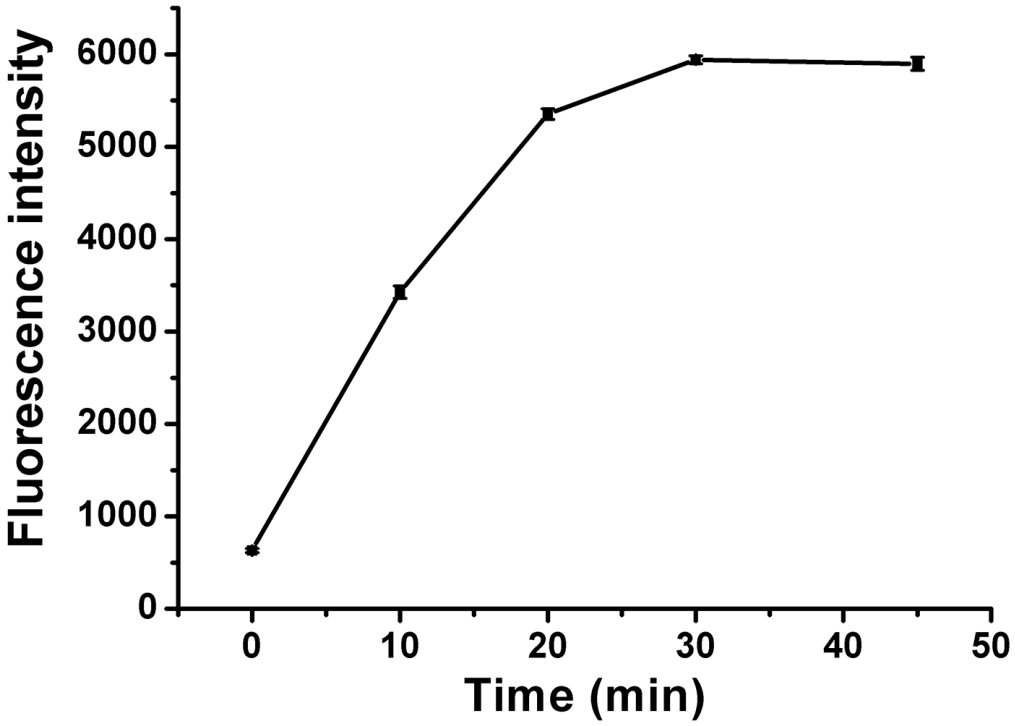

Fig. S4 Optimization of the reaction time for Exo III-fuelled DNA reaction.

Table S2 Comparison of currently available aptamer-based methods for the detection of SARS-CoV-2 spike protein.

Method	Mechanism	Materials	Assay time	Linear range	LOD	Real sample	Ref
Mxene-based fluorescent method	Target-induced direct signal change	Mxene	30 min	100 fg mL^{-1} to 1 ng mL^{-1}	38.9 fg mL^{-1}	Clinical swab samples	[S1]
Fluorescent method based on allosteric aptasensor-initiated target cycling and transcription amplification	Target-regulated strand competition	/	180 min	5.07 ng mL^{-1} to 76.05 ng mL^{-1}	5.07 ng mL^{-1}	Artificial serum sample	[S2]
Near-infrared fluorescent method based on covalent DNA anchors	Target-induced direct signal change	Carbon nanotube	30 min	Not provided	38 ng mL^{-1}	Artificial saliva sample	[S3]
Electrochemical method based on triangular prism DNA nanostructures and dumbbell hybridization chain reaction	Target-regulated strand competition	Triangular DNA prism	135 min	1 pg mL^{-1} to 1 ng mL^{-1}	38 fg mL^{-1}	Clinical swab samples	[S4]
Electrochemical method based on aptamer-binding induced multiple hairpin assembly signal amplification	Target-regulated strand competition	/	75 min	50 fg mL^{-1} to 50 ng mL^{-1}	9.79 fg mL^{-1}	Artificial swab sample	[S5]
Aptamer-based method based on	Target-induced	Gold	40 min	507 pg mL^{-1}	66 pg	SARS-CoV-2	[S6]

electrochemical impedance spectroscopy	direct signal change	nanoparticle		to 1.27 μg mL^{-1}	mL^{-1}	pseudovirus	
Fluorescent method based on kinetically-controlled DNA reactions and MOF nanoprobes	Target-regulated kinetically-controlled DNA displacement	MOF	110 min	10 fg mL^{-1} to 10 ng mL^{-1}	7.8 fg mL^{-1}	Artificial saliva and serum sample	This work

References

S1. Y. Luo, X. Jiang, R. Zhang, C. Shen, M. Li, Z. Zhao, M. Lv, S. Sun, X. Sun and B. Ying. *Small*, 2023, **19**, 2301146.

S2. D. Song, D. Yuan, X. Tan, L. Li, H. He, L. Zhao, G. Yang, S. Pan, H. Dai, X. Song and Y. Zhao. *Sens. Actuators B Chem.*, 2022, **371**, 132526.

S3. J. T. Metternich, J. A. C. Wartmann, L. Sistemich, R. Nibler, S. Herbertz and S. Kruss. *J. Am. Chem. Soc.*, 2023, **145**, 14776-14783.

S4. Y. Jiang, X. Chen, N. Feng and P. Miao. *Anal. Chem.*, 2022, **94**, 14755-14760.

S5. J. Xue, Y. Li, J. Liu, Z. Zhang, R. Yu, Y. Huang, C. Li, A. Chen and J. Qiu. *Talanta*, 2022, **248**, 123605.

S6. J. C. Abrego-Martinez, M. Jafari, S. Chergui, C. Pavel, D. Che and M. Siaj. *Biosens. Bioelectron.*, 2022, **195**, 113595.

Table S3 Comparison of SARS-CoV-2 spike protein concentrations detected in saliva samples by the method and the standard given concentrations.

Sample	Detected		Standard concentration	Recovery (%)
	Concentration	RSD (%)		
1	103.6 fg mL^{-1}	3.71	100 fg mL^{-1}	103.6
2	97.6 pg mL^{-1}	4.26	100 pg mL^{-1}	97.6
3	1047 pg mL^{-1}	4.08	1000 pg mL^{-1}	104.7

Table S4 Comparison of SARS-CoV-2 spike protein concentrations detected in serum samples by the method and the standard given concentrations.

Sample	Detected		Standard concentration	Recovery (%)
	Concentration	RSD (%)		
1	101.7 fg mL^{-1}	4.96	100 fg mL^{-1}	101.7
2	105.3 pg mL^{-1}	2.82	100 pg mL^{-1}	105.3
3	1069 pg mL^{-1}	4.82	1000 pg mL^{-1}	106.9