Electronic Supplementary Material (ESI) for Analytical Methods.

Table S1: Sequences of oligonucleotides used in this study

Name	The sequence of p53 DNA should be
p53 DNA	TCA TCA CAC TGG AAG ACT C
HPa	CTC AGC ACG GCT CTT TCA ACA TCA GTC TGA TAA GCT TCC AAG GAG CCG TGC TGA GTA T
HPb	TTT CGG CTG GTT TAT TTT TAT TTT ATA TAC TCA GCT TTC CAG CCG G
HPc	GGA GCC GTT TAT TTC TTA GTT TCT CCG GCT GTT TCG GCT CC
Biotin-CP	Biotin-TTT TTT TTT AAG CTT ATC AGA CTG ATG AAA ATG AGT ATA TAA AAT TAT ACG GAG AAA CTA AGA
RP	TCA ACA TCA GTC TGA TAA GCT ACC CTC AGC GAG TCT TCC AGT GTG ATG A
T1	TCA TCA CAC TGG AAG AAT C
T2	TCA TCA CAC TGG AAG GAT C
Tn	GGT CTC TTG ATA GCA CTC G

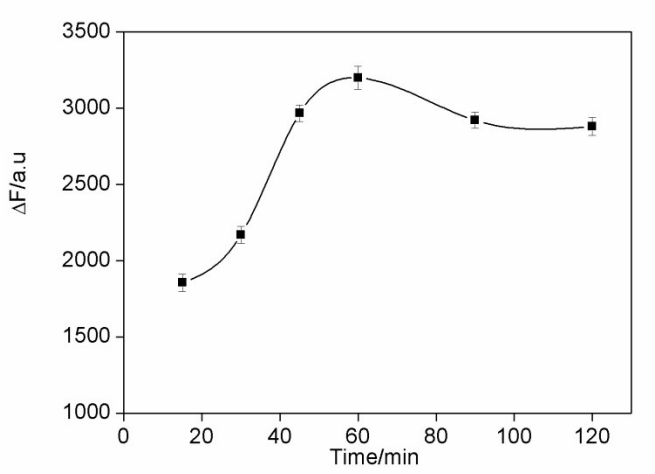

Fig S1 Fluorescence intensity versus first SDA reaction time in the sensing system. RP, 1 μM; P53 DNA, 0.5 μM; dNTPs, 10 mM; Nb.BvCI, 2.5 U; KFP, 1U; HPa, HPb, HPc, 1 μM; SG I, 10×.

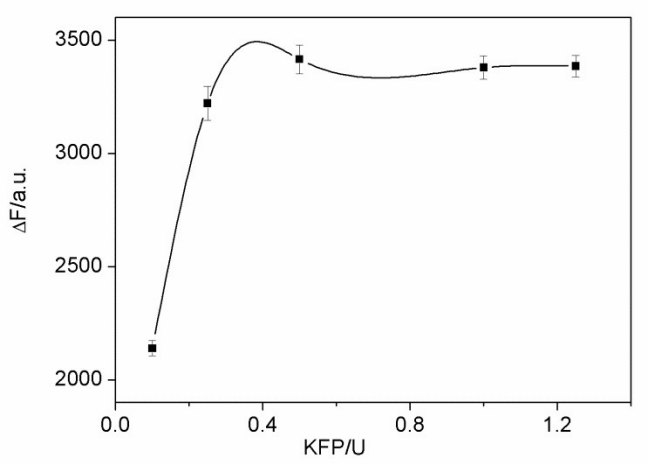

Fig S2 Fluorescence intensity versus the dosage of polymerase（KFP）in the sensing system. RP, 1 μM; P53 DNA, 0.5 μM; dNTPs, 10 mM; Nb.BvCI, 2.5 U; HPa, HPb, HPc, 1 μM; SG I, 10×; first SDA reaction time 60 min.

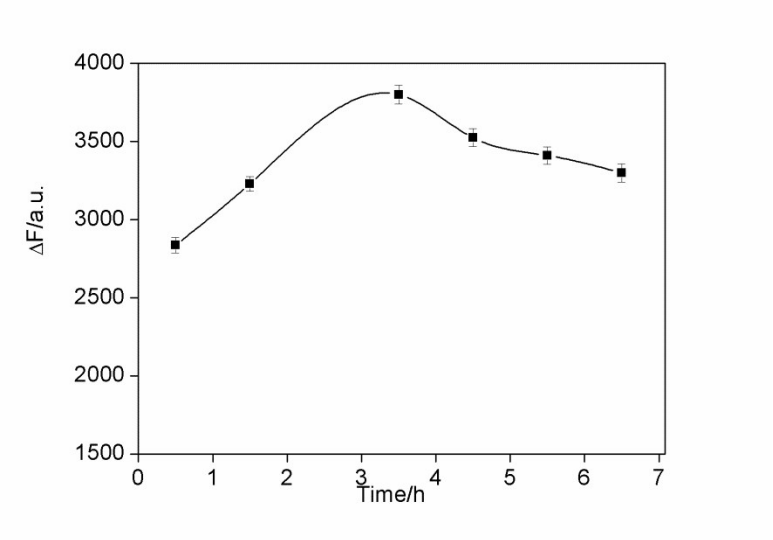

Fig.S3 Fluorescence intensity versus the reaction time of downstream SDA in the sensing system. RP, 1 μM; P53 DNA, 0.5 μM; dNTPs, 10 mM; Nb.BvCI, 2.5 U; KFP 0.5 U; HPa, HPb, HPc, 0.6 μM; SG I, 10×; first SDA reaction time 60 min.

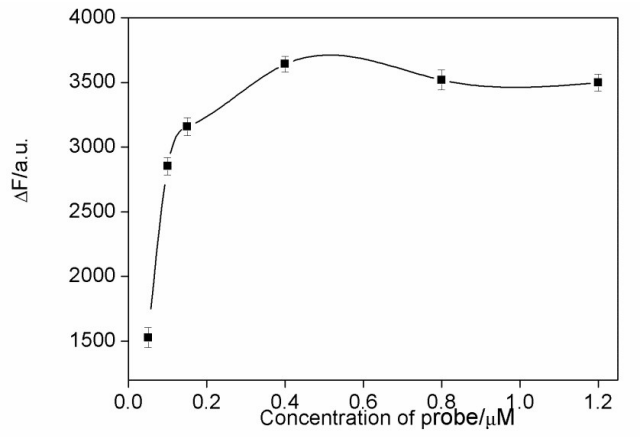

Fig.S4 Fluorescence intensity versus the concentration of HPn probe in the sensing system. RP, 1 μM; P53 DNA, 0.5 μM; dNTPs, 10 mM; Nb.BvCI, 2.5 U; KFP 0.5 U; SG I, 10×; first SDA reaction time 60 min.

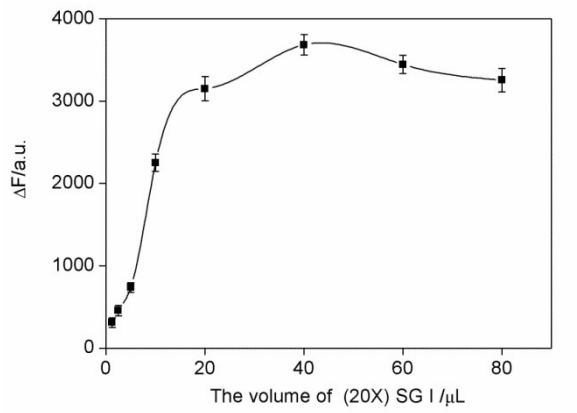

Fig.S5 Fluorescence intensity versus the dosage of SG I (20X) in the sensing system. RP, 1 μM; P53 DNA, 0.5 μM; dNTPs, 10 mM; Nb.BvCI, 2.5 U; KFP 0.5 U; HPa, HPb, HPc, 0.6 μM; first SDA reaction time, 60 min, the downstream SDA, 3.5 h.

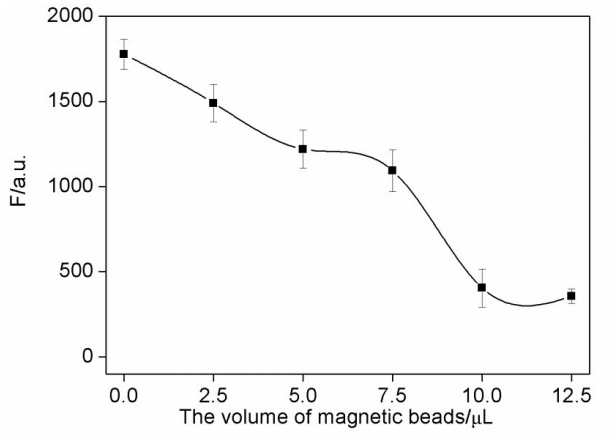

Fig.S6 Fluorescence intensity versus dosage of magnetic sphere in the sensing system. RP, 1 μM; dNTPs, 10 mM; Nb.BvCI, 2.5 U; KFP 0.5 U; HPa, HPb, HPc, 0.6 μM; SG I, 20×.

Table S2. Comparison of different methods for p53 gene detection

Method	Nucleic acid amplification strategy	Detection limit	Detection Range	Ref.
Electrochemical	Rolling circle amplification	0.36 pM	0.5-10 pM	[1]
Fluorescence	Multiple strand displacement amplification	10 pM	10 pM-70 nM	[2]
Fluorescence	Reverse strand displacement amplification	1 nM	1-100 nM	[3]
Electrochemiluminescence	*NA*	0.03 nM	0.1-15 nM	[4]
Quartz crystal microbalance	*NA*	0.3 nM	not given	[5]
Quartz crystal microbalance	*NA*	0.1 nM	0.5-25 nM	[6]
Electrochemistry	*NA*	230 pM	1.0-95 nM	[7]
Colorimetric	Rolling circle amplification	25 fM	2.5fM-2.5nM	[8]
Electrochemical	NA	3nM	2.9-3.4nM	[9]
Fluorescence	Rolling circle	0.07 fM	0.1 -500 fM	[10]

	amplification			
Electrochemiluminescence	Hyperbranched Rolling Circle Amplification	0.02 fM	0.05 -100 fM	[11]
Fluorescence	Double strand displacement amplification	0.012 nM	0.01-1 nM	**This work**

Table S3. Detection of p53 gene in spiked urine samples by the proposed sensing system

sample	**Added** p53 gene/nM	**Measured** p53 gene/nM	**Recovery/%**	**RSD/%**
1	1.0	1.08	108.0	7.12
2	0.2	0.195	97.50	6.87
3	0.02	0.021	105.0	6.47

References

1. Y. j. Jia, F. F. Sun, N. Na and J. Ouyang, *Anal. Chim. Acta*, 2019, **1060**, 64.
2. C. Xue, S. Xiao a, C. H. Ouyang, C. C. Li, Z. H. Gao, Z. F. Shen and Z. S. Wu, *Anal. Chim. Acta*, 2019, **1051**, 179.
3. L. S. Wang, Y. Han, S. Xiao, S. Lv, C. Wang, N. Zhang, Z. Y. Wang, Y. Q. Tang, H. B. Li, J. X. Lyu, H. Xu and Z. F. Shen, *Talanta*, 2018, **187**, 365.
4. Y. Liu, X. Q. Chen and Q. Ma, *Biosens. Bioelectron.*, 2018, **117**, 240.
5. D. Z. Wang, W. Tang, X. J. Wu, X. Y. Wang, G. J. Chen, Q. Chen, N. Li and F. Liu, *Anal. Chem.*, 2012, **84**, 7008.
6. W. Tang, D. Z. Wang, Y. Xu, N. Li and F. Liu, *Chem. Commun.,* 2012, **48**, 6678.
7. Z. Dai, T. Cai, W. Y. Zhu, X. Y. Gao and X. Y. Zou, *Chem. Commun.*, 2013, **49**, 1939.
8. H. B. Li, Z. S. Wu, L. P. Qiu, J. W. Liu, C. Wang, G. L. Shen and R. Q. Yu, *Biosens. Bioelectron.,* 2013, **50**, 180.
9. B. Esteban-Fernandez de Avila, E. Araque, S. Campuzano, M. Pedrero, B. Dalkiran, R. Barderas, R. Villalonga, E. Kilic and J. M. Pingarron, *Anal. Chem.*, 2015, **87**, 2290.
10. X. Li, J. Song, Q. W. Xue, H. Y. Zhao, M. Liu, B. L. Chen, Y. Liu, W. Jiang and C. Z. Li, *Analyst*, 2017, **142**, 3598.
11. L. L. Yang, Y. Z. Tao, G. Y. Yue, R. B. Li, B. Qiu, L. H. Guo, Z. Y. Lin and H. H. Yang, *Anal. Chem.*, 2016, **88**, 5097.