A Homogeneous Hybridization Magnetic Biosensor Based on Electric Field Assistance for Ultrafast Nucleic Acid Detection

Jinling Cui,[#a, b] Ritong Sun,[#a] Xiaoli Zhao,[a] Mingyuan Zhao,[a] Xiaojun Zhang,[a] Yong Li,[a] Lei Wang,[b] Chao Shi,[c] and Cuiping Ma,*[a]

a. *Shandong Provincial Key Laboratory of Biochemical Engineering, Qingdao Nucleic Acid Rapid Detection Engineering Research Center, College of Marine Science and Biological Engineering, Qingdao University of Science and Technology, Qingdao, 266042, PR China.*

b. *College of Chemistry and Molecular Engineering, State Key Laboratory Base of Eco-Chemical Engineering, International Science and Technology Cooperation Base of Eco-chemical Engineering and Green Manufacturing, Qingdao University of Science and Technology, Qingdao 266042, China*

c. *Qingdao Nucleic Acid Rapid Testing International Science and Technology Cooperation Base, College of Life Sciences, Department of Pathogenic Biology, School of Basic Medicine, the Clinical Laboratory Department of the Affiliated Hospital of Qingdao University, Qingdao University, Qingdao, 266071, PR China*

*Corresponding author. Tel (Fax): +86-0532-88956928; E-mail: mcp169@163.com
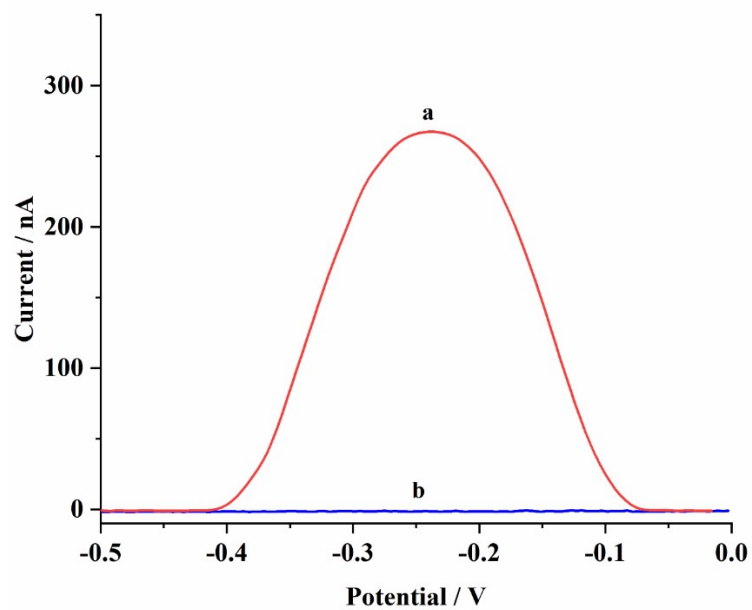
Fig. S1 DPV response curves of magnetic gold electrode. (a) represented magnetic gold electrode modified with PPy and CNTs. (b) represented unmodified magnetic gold electrode.
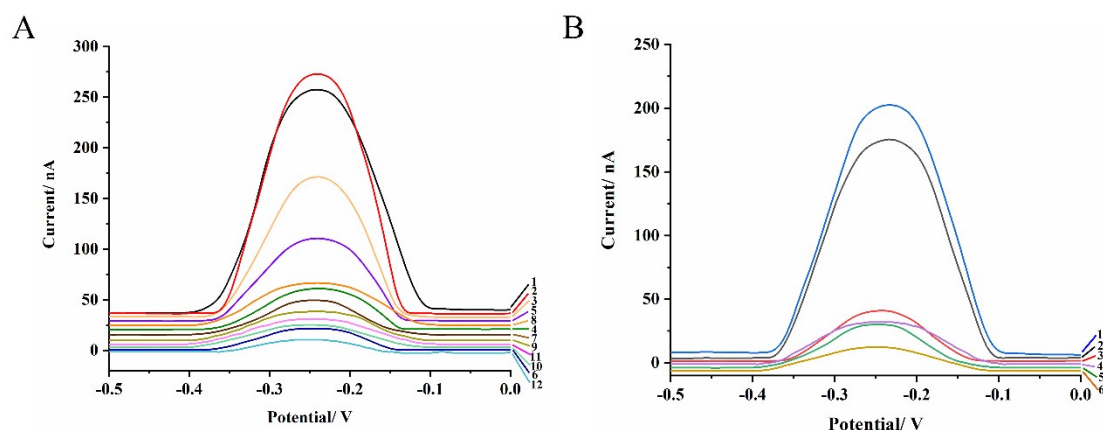
Fig. S2 Comparison of electric field assistance and non-electric field assistance.

(A) The DPV response curves of hybridization under different conditions. 1. electric-assisted hybridization 90 s; 2. non-electric-assisted hybridization 2 h; 3. non- electric-assisted hybridization 1 h; 4. non- electric-assisted hybridization 45 min; 5. non-electric-assisted hybridization 30 min; 6. non-electric-assisted hybridization 90 s; 7. background signal of electric-assisted hybridization 90 s; 8. background signal of non-electric-assisted hybridization 2 h; 9. background signal of non- electric-assisted hybridization 1 h; 10. background signal of non-electric-assisted hybridization 45 min; 11. background signal of non-electric-assisted hybridization 30 min; 12. background signal of non-electric-assisted hybridization 90 s. (B) The DPV response curves of coupling under different conditions. 1. electric-assisted coupling for 5 min; 2. non-electric-assisted coupling for 30 min; 3. non-electric-assisted coupling for 5 min; 4. background signal of electric-assisted coupling for 5 min; 5. background signal of non-electric-assisted coupling for 30 min; 6. background signal of non-electric-assisted coupling for 5 min.
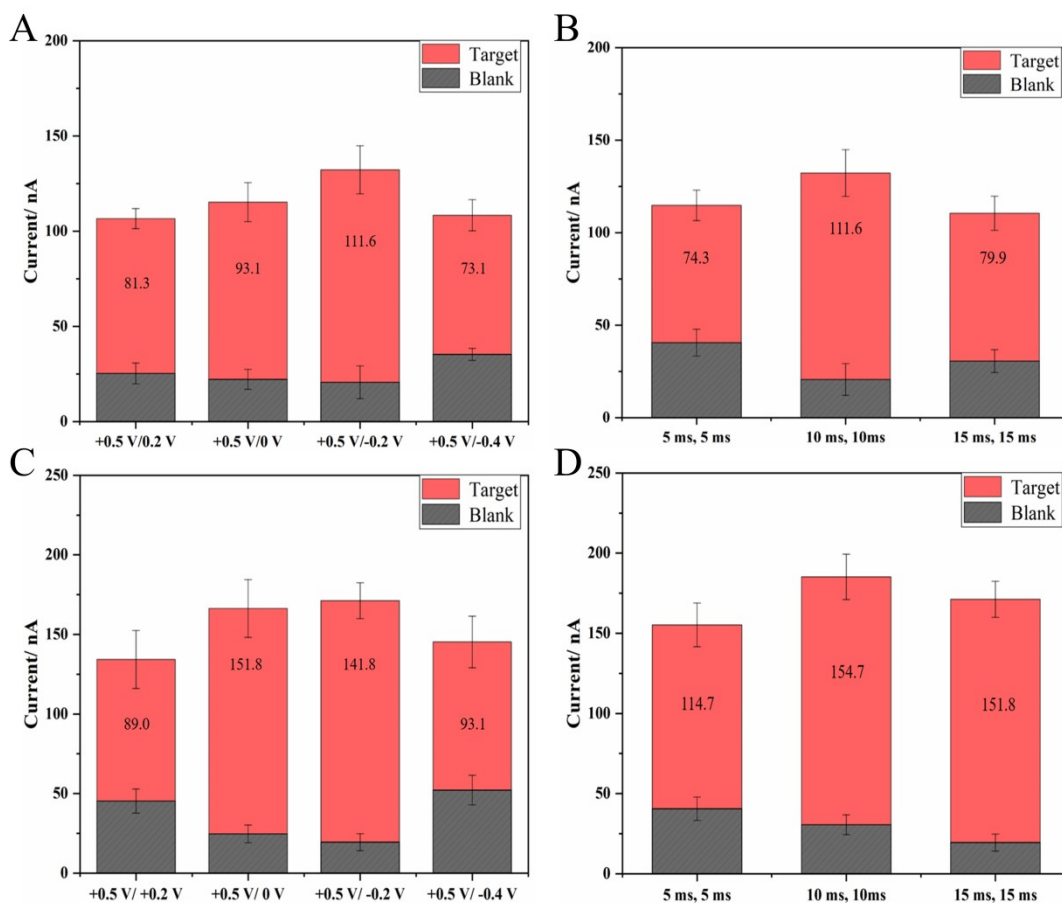
Fig. S3 Optimization of pulse profile and pulse interval. The marked value reflects the D-value between hybrid signal and background signal. (A) Optimization of electric-assisted hybridization pulse profile under the conditions of hybridization pulse interval of 10 ms, the hybridization time of 60 s, the coupling pulse profile of +0.5 V/-0.2 V, the coupling pulse interval of 10 ms, the coupling time of 3 min and target concentration of 10 nM. (B) Optimization of electric-assisted hybridization pulse interval under the conditions of hybridization pulse profile of +0.5 V/-0.2 V, hybridization time of 60 s, coupling pulse profile of +0.5 V/-0.2 V, coupling pulse interval of 10 ms, coupling time of 3 min and target concentration of 10 nM. (C) Optimization of electric-assisted coupling pulse profile under the conditions of hybridization pulse profile of +0.5 V/-0.2 V, hybridization pulse interval of 10 ms, hybridization time of 90 s, coupling pulse interval of 10 ms, coupling time of 3 min and target concentration of 10 nM. (D) Optimization of electric-assisted coupling pulse interval under the conditions of hybridization pulse profile of +0.5 V/-0.2 V, hybridization pulse interval of 10 ms, hybridization time of 90 s, coupling pulse profile of +0.5 V/-0.2 V, coupling time of 3 min and target concentration of 10 nM.

Table S1 Sequences of the probes of the magnetic biosensor based on electrical potential assistance.

Name	Sequence (5'-3')
Capture probe	GCAGACATCCACATAC-biotin
Detection probe	MB-AAGTGTGAGGGCTGA
Target	TGGATGTCTGCTACAGGCATTCTTTTCAGCC CTCACACTT
Two-base mismatch DNA	TGAATCTCTGCTACAGGCATTCTTTTCAGCC CTCACACTT
Three-base mismatch DNA	TGGAACGCTGCTACAGGCATTCTTTTCAGCC CTCACACTT
Non-mismatch DNA	CGCGTTCACGAAACCGTGCTGATACTCACG CCTTGTTCGA

Table S2 Recovery tests for target DNA in complex biological environments.

Samples	Spiked(nM)	Found(nM)	RSD(%)	Recovery(%)
PBS	10	10.91	9.07	109.1
Saliva	10	9.64	7.14	96.4
10% bovine Serum	10	8.95	4.22	89.5
25% bovine Serum	10	7.47	9.62	74.7