Supplementary Information

Sweetsop-like α-Fe_2O_3@CoNi catalyst with superior peroxidase-like activity for sensitive and selective detection of hydroquinone

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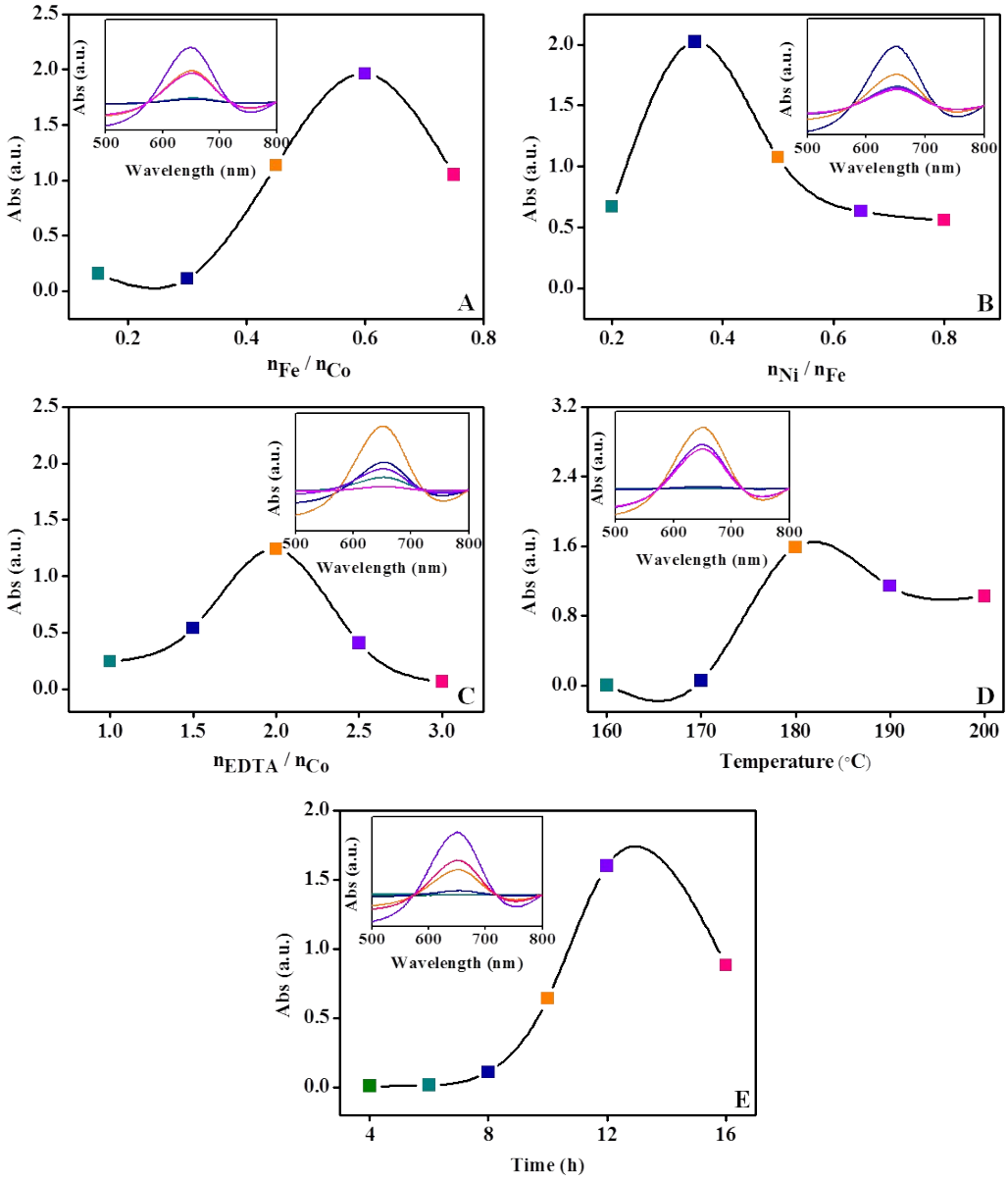
Table S1. Comparison of Kinetic parameters (K_m and V_{max}).

Catalyst	Substrate	$V_{max(}10^{-8}M\cdot s^{-1}$)	K_m(mM)	Ref.
α-Fe_2O_3@CoNi	TMB	13.5	0.23	This work
	H_2O_2	9.3	0.42	
Fe SSN	TMB	20.4	0.53	[1]
	H_2O_2	13.2	0.36	
CDs@ZIF-8-a	TMB	1.95	0.232	[2]
	H_2O_2	1.22	0.737	
CB-CQDs	TMB	5.13	0.83	[3]
	H_2O_2	4.09	0.70	
Co_9S_8	TMB	99	1.64	[4]
	H_2O_2	35	7.39	
Por-$NiCo_2S_4$	TMB	34.86	0.3	[5]
	H_2O_2	4.32	4.5	
HRP	TMB	10	0.43	[6]
	H_2O_2	8.71	3.70	

Table S2. Comparison of the proposed method with other methods for the detection of HQ.

No.	Method	Materials	Linear Rang(μM)	LOD(μM)	Ref.
1	Colorimetry	Pt/CdS	1.0-10	0.165	[7]
2	Colorimetry	$ZnO/ZnFe_2O_4$	0-150	3.75	[6]
3	Colorimetry	$NiCo_2O_4$	5-110	2.70	[8]
4	Fluorescence	SiQDs	6-100	2.63	[9]
5	Fluorescence	g-CNQDs	0.5-11.6	0.04	[10]
6	Fluorescence	N/S/P-codoped CDs	0.56-375	0.16	[11]
7	ECL	MOF-rGO	10-200	0.66	[12]
8	ECL	CoTFPP/GO/GCE	1-200	0.21	[13]
9	ECL	$CoFe_2Se_4$/PCF	0.5-200	0.13	[14]
10	Colorimetry	α-Fe_2O_3@CoNi	0.5-30	0.16	This work



19 **Fig. S1** Optimization of Co, Ni and EDTA dosage (A, B, C), synthesis temperature and

20 time (D and E), (inset) the oxTMB of corresponding absorption spectra.

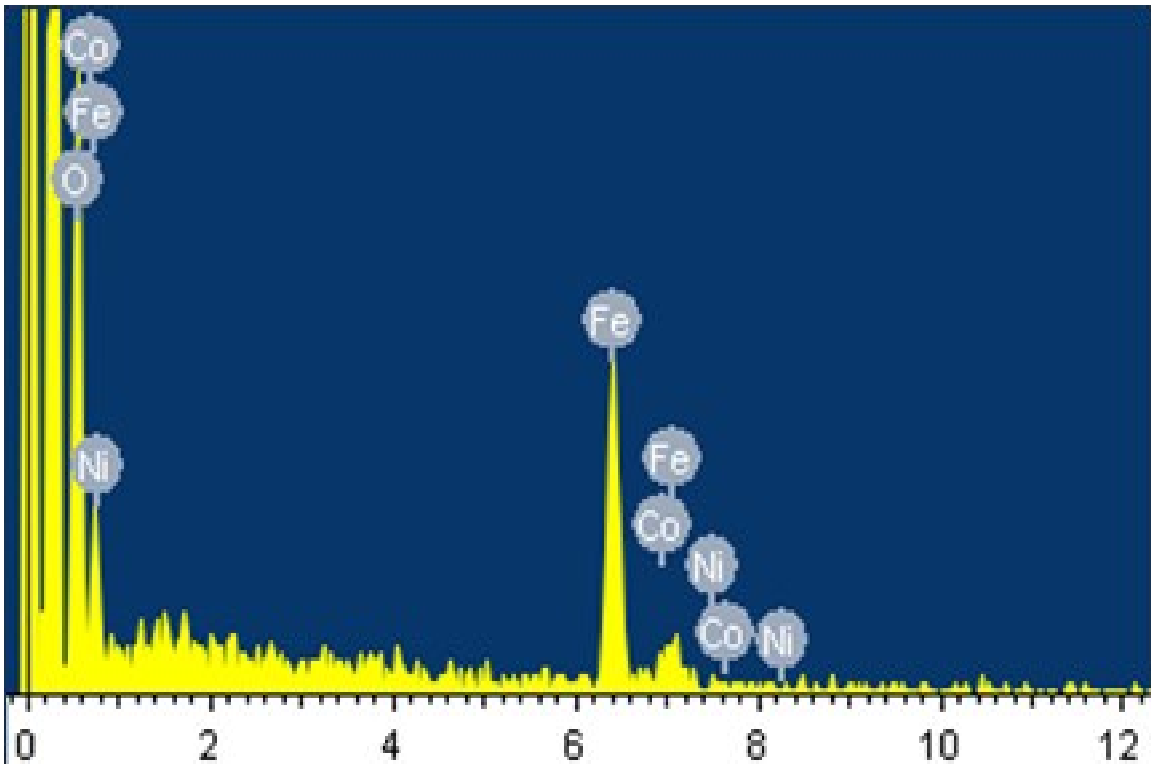
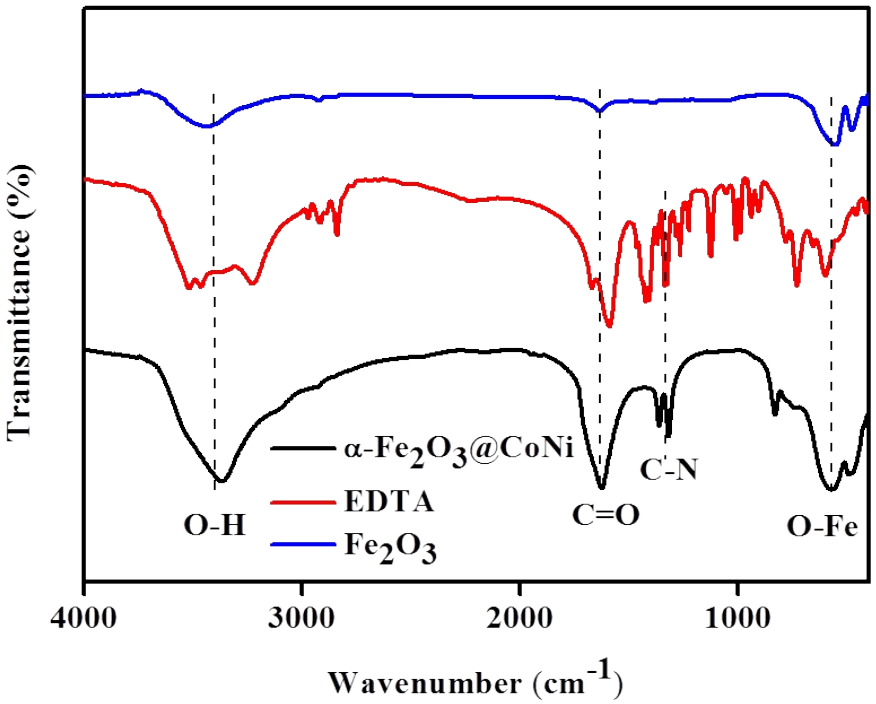


Fig. S2 Energy dispersive spectrometer (EDS) image of α-Fe_2O_3@CoNi.



22 **Fig. S3** The FT-IR spectra of α-Fe_2O_3@CoNi, commercial Fe_2O_3 and EDTA.

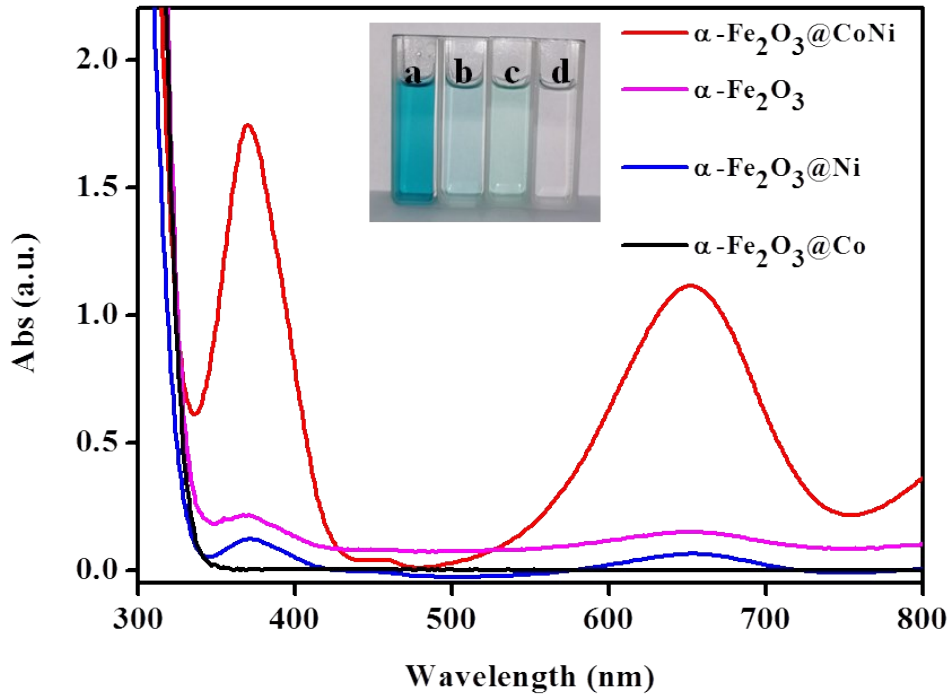


Fig. S4 The UV-vis absorption spectrum of commercial Fe_2O_3, α-Fe_2O_3@Co, α-Fe_2O_3@Ni and α-Fe_2O_3@CoNi in TMB/H_2O_2 system. (inset) The color of corresponding solutions. (a) TMB+H_2O_2+α-Fe_2O_3@CoNi, (b) TMB+H_2O_2+Fe_2O_3 (c) TMB+H_2O_2+α-Fe_2O_3@Ni, (c) TMB+H_2O_2+α-Fe_2O_3@Co.

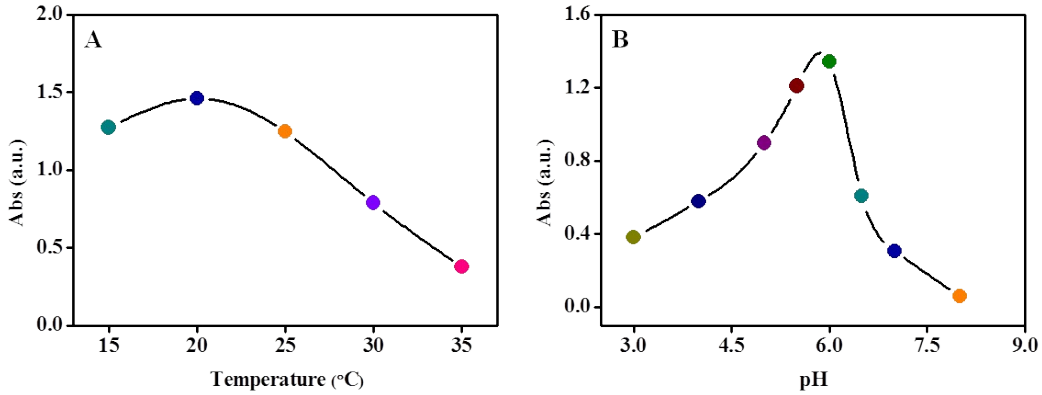
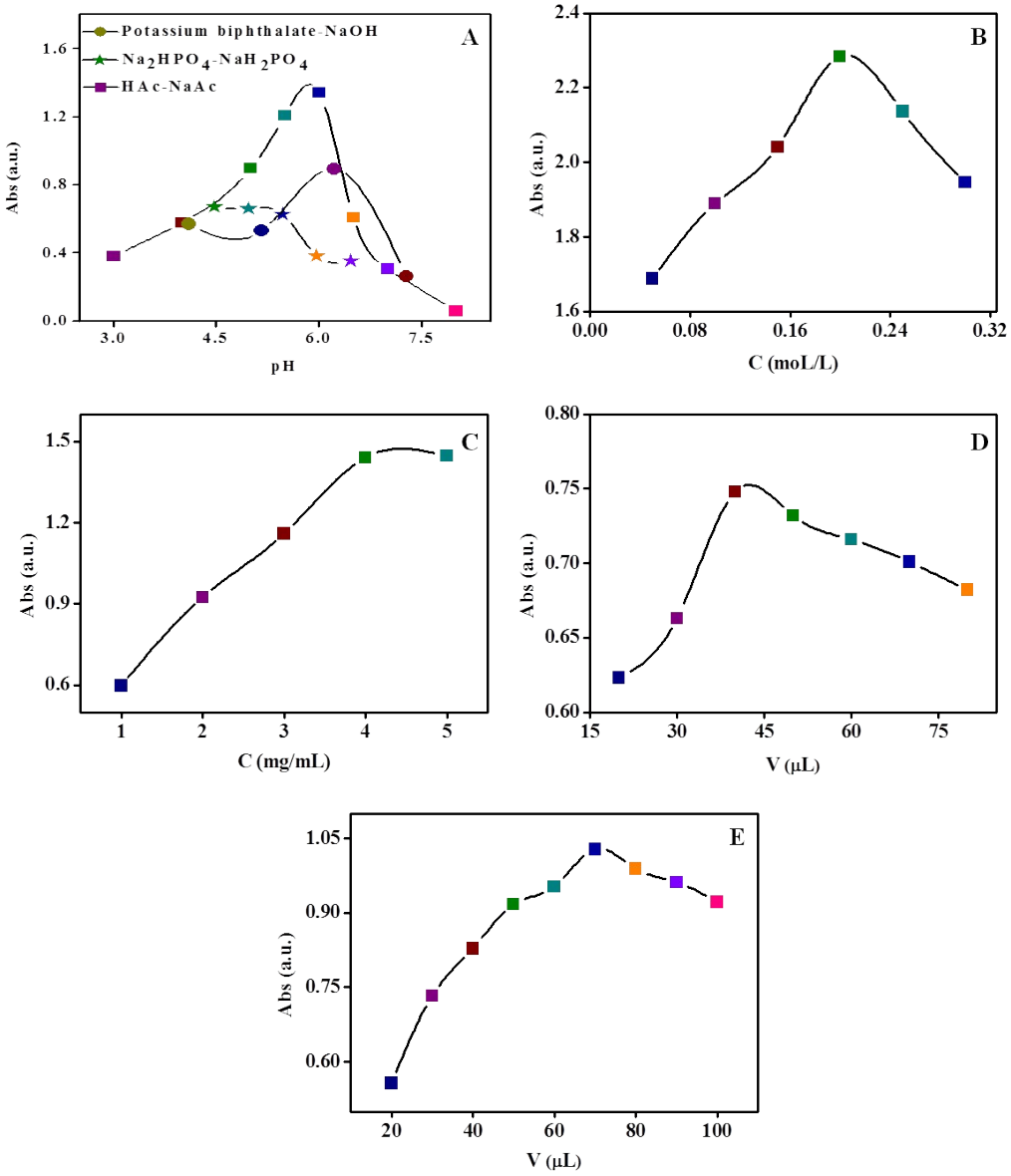


Fig. S5 Effects of temperature (A) and pH (B) on the catalytic activity of α-Fe_2O_3@CoNi.



31 **Fig. S6** Effects of type and concentration of buffer solution (A, B), concentration of α-

32 Fe_2O_3@CoNi (C), dosage of TMB (D) and H_2O_2 (E) on the catalytic activity of α-

33 Fe_2O_3@CoNi.

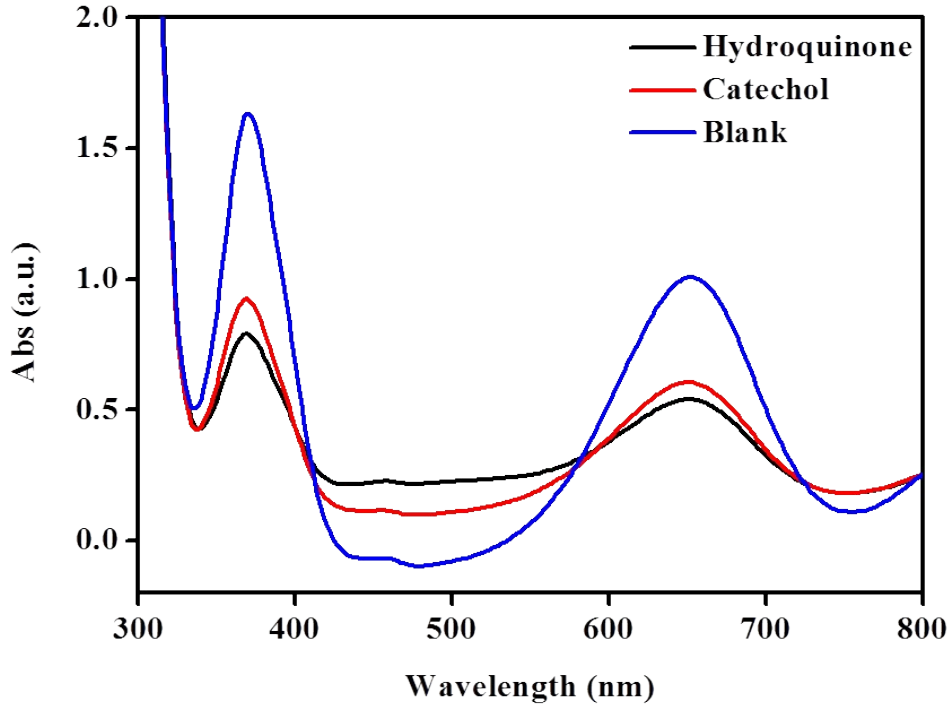


Fig. S7 The UV-vis absorption spectrum of hydroquinone (30 μM) and Catechol (30 μM) in α-Fe_2O_3@CoNi/TMB/H_2O_2 system and blank control.

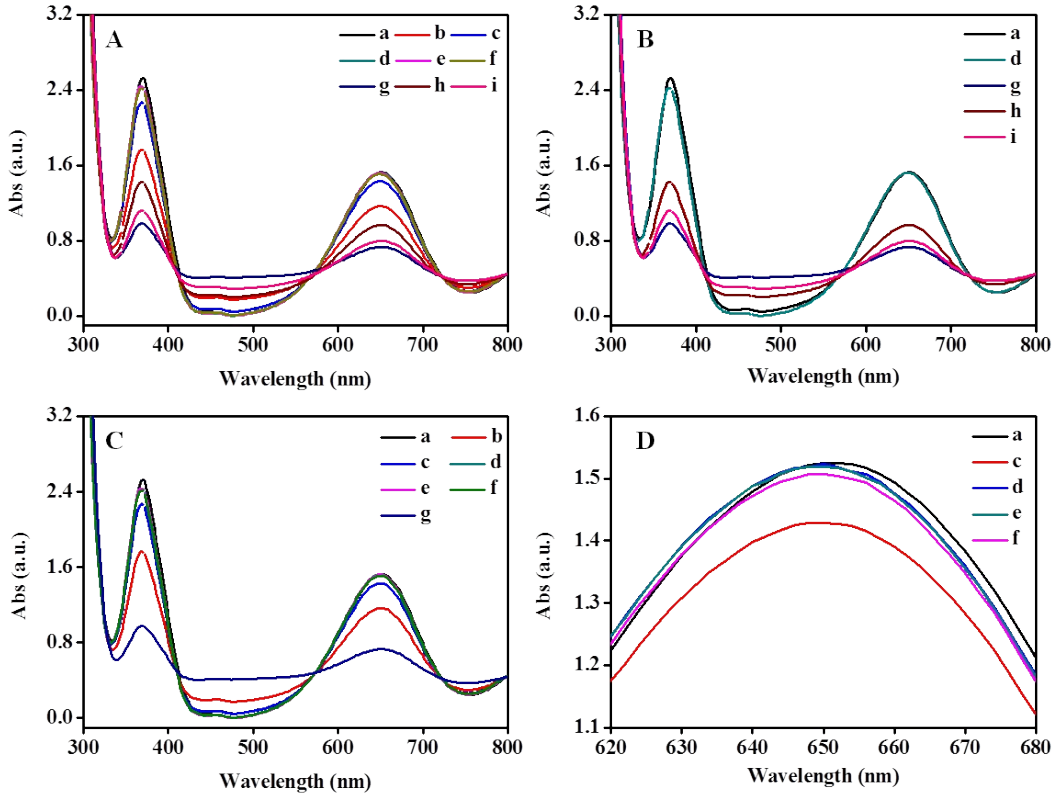
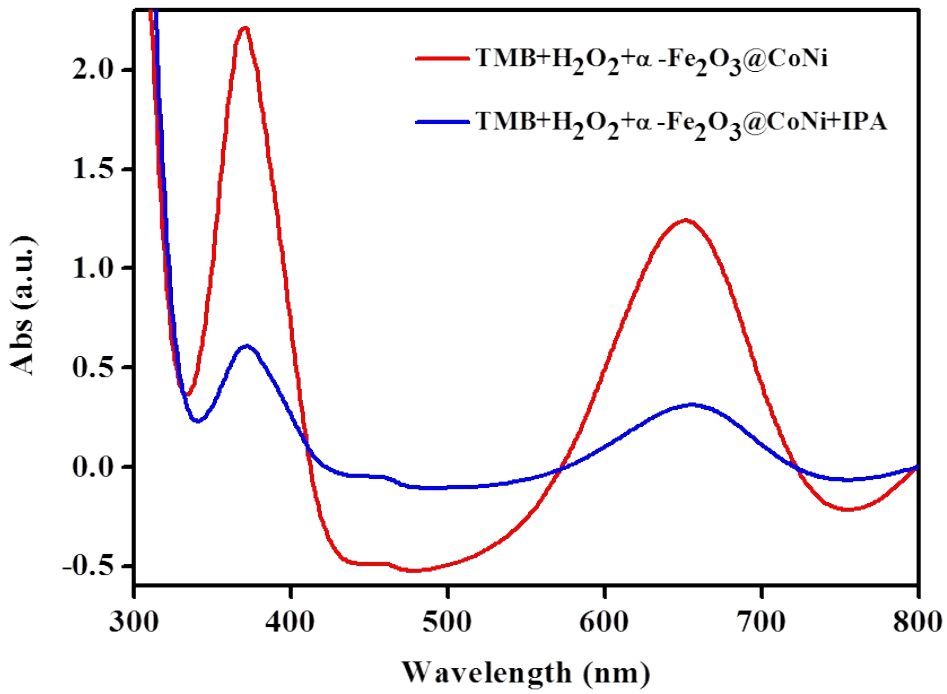


Fig. S8 The UV-vis absorption spectrum of TMB+H_2O_2+α-Fe_2O_3@CoNi system with different alumina additions (a, blank; b-f, 0.1-0.5g alumina added into 2 mL 0.006 M HQ solution; g, catechol solution before alumina treatment; h-i, HQ solution before and after alumina treatment, respectively).



43 **Fig. S9** The effect of isopropyl alcohol (IPA) on the catalytic activity of α-Fe_2O_3@CoNi.

References

[1] M. Chen, H. Zhou, X. Liu, T. Yuan, W. Wang, C. Zhao, Y. Zhao, F. Zhou, X. Wang, Z. Xue, T. Yao, C. Xiong, Y. Wu, Single iron site nanozyme for ultrasensitive glucose detection, Small. 16(2020) 2002343-2002348.

[2] Y. Wang, X. Liu, M. Wang, X. Wang, W. Ma, J. Li, Facile synthesis of CDs@ZIF-8 nanocomposites as excellent peroxidase mimics for colorimetric detection of H_2O_2 and glutathione, Sens. Actuators, B. 329(2021) 129115-129123.

[3] C. Yuan, X. Qin, Y. Xu, X. Li, Y. Chen, R. Shi, Y. Wang, Carbon quantum dots originated from chicken blood as peroxidase mimics for colorimetric detection of biothiols, J. Photoch Photobio A: Chem. 396(2020) 112529-112535.

[4] J. Mu, J. Li, X. Zhao, E.-C. Yang, X.-J. Zhao, Novel urchin-like Co_9S_8 nanomaterials with efficient intrinsic peroxidase-like activity for colorimetric sensing of copper (II) ion, Sens. Actuators, B. 258(2018) 32-41.

[5] Y. He, N. Li, W. Li, X. Zhang, X. Zhang, Z. Liu, Q. Liu, 5,10,15,20-tetrakis (4-carboxylphenyl) porphyrin functionalized $NiCo_2S_4$ yolk-shell nanospheres: Excellent peroxidase-like activity, catalytic mechanism and fast cascade colorimetric biosensor for cholesterol, Sens. Actuators, B. 326(2021) 128850-128860.

[6] X. Wang, M. Zhao, Y. Song, Q. Liu, Y. Zhang, Y. Zhuang, S. Chen, Synthesis of $ZnFe_2O_4$/ZnO heterostructures decorated three-dimensional graphene foam as peroxidase mimetics for colorimetric assay of hydroquinone, Sens. Actuators, B. 283(2019) 130-137.

[7] X. Zhao, H. Lyu, X. Yao, C. Xu, Q. Liu, Z. Liu, X. Zhang, X. Zhang, Hydroquinone colorimetric sensing based on platinum deposited on CdS nanorods as peroxidase mimics, Microchim. Acta. 187(2020) 587-596.

[8] Y. Song, M. Zhao, H. Li, X. Wang, Y. Cheng, L. Ding, S. Fan, S. Chen, Facile preparation of urchin-like $NiCo_2O_4$ microspheres as oxidase mimetic for colormetric assay of hydroquinone, Sens. Actuators, B. 255(2018) 1927-1936.

[9] Y. Liu, Q. Wang, S. Guo, P. Jia, Y. Shui, S. Yao, C. Huang, M. Zhang, L. Wang, Highly selective and sensitive fluorescence detection of hydroquinone using novel silicon quantum dots, Sens. Actuators, B. 275(2018) 415-421.

[10] J. Chen, Y. Gao, X. Hu, Y. Xu, X. Lu, Detection of hydroquinone with a novel fluorescence probe based on the enzymatic reaction of graphite phase carbon nitride quantum dots, Talanta. 194(2019) 493-500.

[11] Y. Wang, Q. Yue, L. Tao, C. Zhang, C.Z. Li, Fluorometric determination of hydroquinone by using blue emitting N/S/P-codoped carbon dots, Microchim. Acta. 185(2018) 550-558.

[12] H. Wang, Q. Hu, Y. Meng, Z. Jin, Z. Fang, Q. Fu, W. Gao, L. Xu, Y. Song, F. Lu, Efficient detection of hazardous catechol and hydroquinone with MOF-rGO modified carbon paste electrode, J. Hazard. Mater. 353(2018) 151-157.

[13] D.L. Huang, J. Wang, F. Cheng, A. Ali, H.S. Guo, X. Ying, L.P. Si, H.Y. Liu, Synergistic effect of a cobalt fluoroporphyrin and graphene oxide on the simultaneous voltammetric determination of catechol and hydroquinone, Microchim. Acta. 186(2019) 381-391.

[14] D. Yin, J. Liu, X. Bo, L. Guo, Cobalt-iron selenides embedded in porous carbon nanofibers for simultaneous electrochemical detection of trace of hydroquinone, catechol and resorcinol, Anal. Chim. Acta. 1093(2020) 35-42.