Supplementary Information

Facile synthesis of Co_3O_4/g-C_3N_4 with enhanced peroxidase-like activity for colorimetric detection of glutathione and L-cysteine

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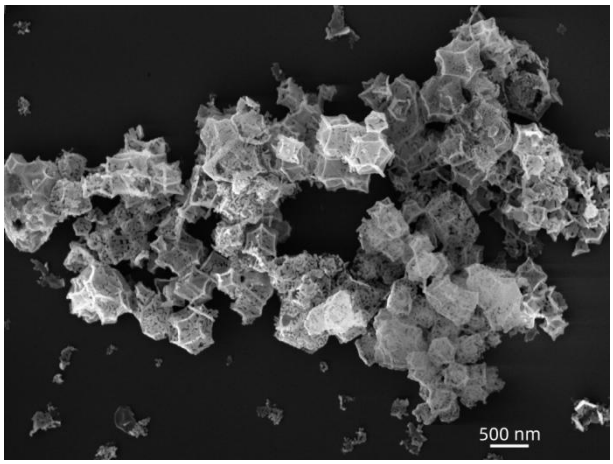

Fig.S1 The FESEM image of Co_3O_4.

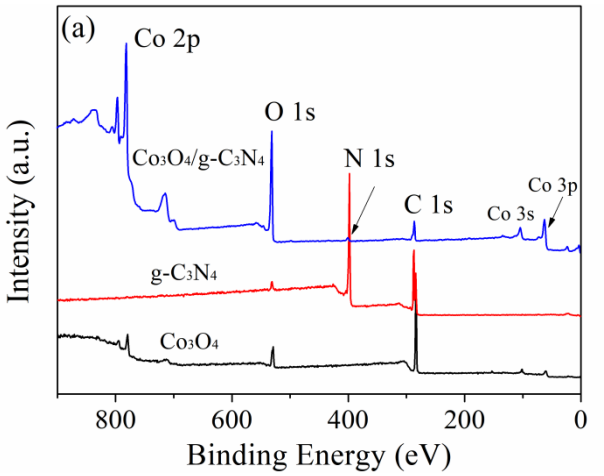

Fig.S2 The survey scan spectrum of Co_3O_4, g-C_3N_4 and Co_3O_4/g-C_3N_4.

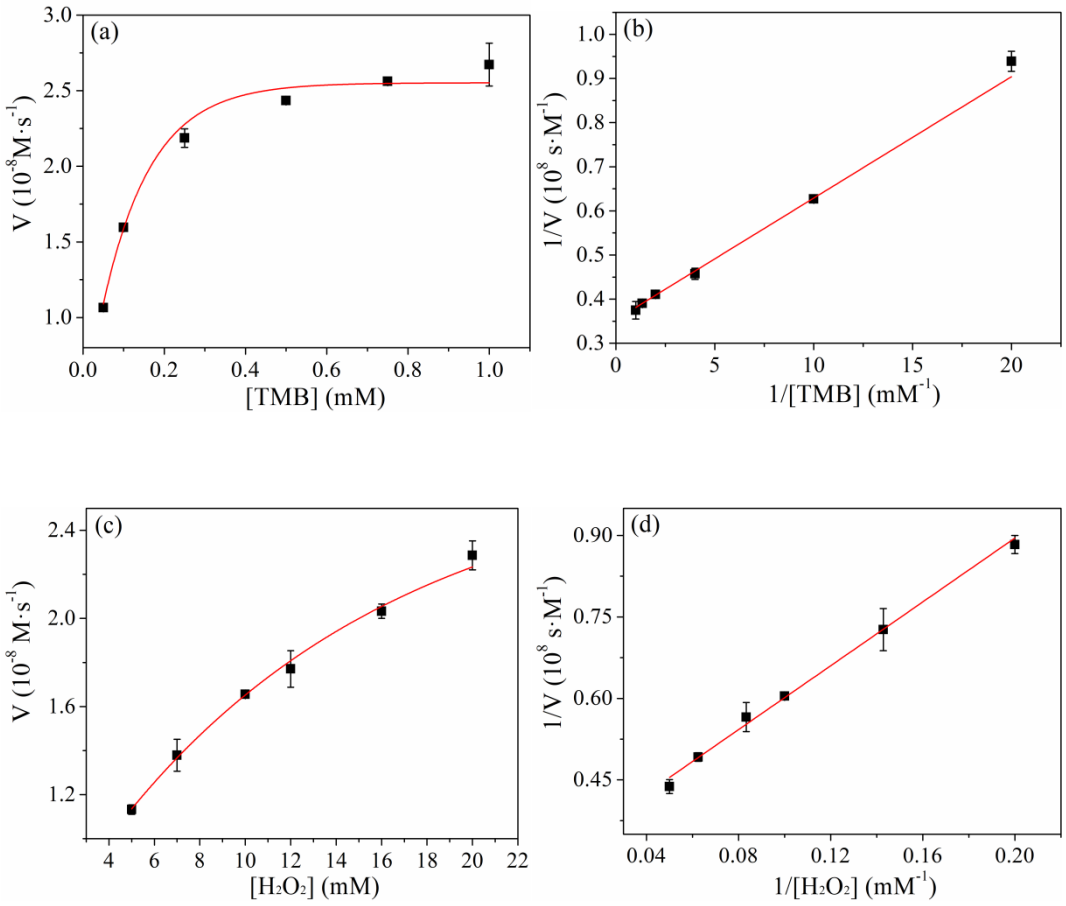

Fig.S3 Peroxidase kinetic analysis of Co_3O_4: (a) Variation of TMB at the concentration of H_2O_2 fixed at 10.0 mM; (b) The Linewear-Burk plots corresponding to (a); (c) Variation of H_2O_2 at the concentration of TMB fixed at 0.5 mM; (d) The Linewear-Burk plots corresponding to (c).

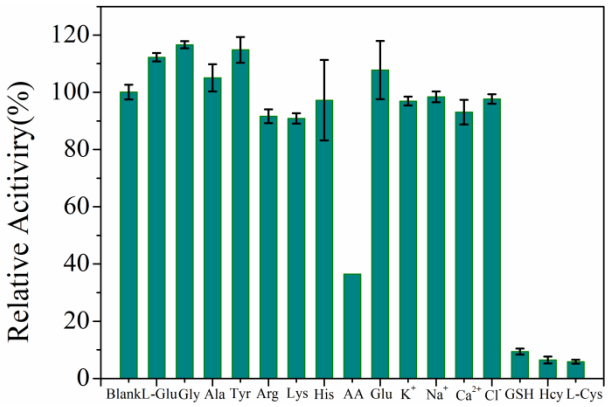

Fig.S4 The selectivity of colorimetric detection system developed based on the Co_3O_4/g-C_3N_4 nanoenzyme with different substances.

Table S1 Comparison of detection performance for GSH or L-Cys in current reports

Nanonzymes	GSH		L-Cys		Ref
	Linear Range	LOD	Linear Range	LOD	
Co_3Fe-MMOF	0.012~0.2 mM	0.07 mM			[1]
Cu@Co-MOFs	1~1200 μM	0.72 μM			[2]
m-CuS	1~20 μM 20~300 μM	0.1 μM			[3]
Sr-MnO_2	5~40 μM	0.46 μM			[4]
MIL-88A(Fe)	0~40 μM	0.15 μM			[5]
Co-N-C			0.1~10 μM	0.1 μM	[6]
Cu-BPTZ-POM/g-C_3N_4(3)			0.1~30 μM	0.047 μM	[7]
Fe,N-GQDs			0.5~50 μM	0.14 μM	[8]
L-His@AuNCs			1~7 μM	0.8 μM	[9]
Co-HPNC@NC			1~40 μM 40~110 μM	0.17 μM	[10]
Co_3O_4/g-C_3N_4	0~30 μM	0.54 μM	1~30 μM	0.52 μM	This work

References

[1] X. X. Wei, S. Y. Qi, T. T. Fu, H. G. Zhu, Z. Y. Meng, W. Q. Gong, J. X. Qiu, D. P. Xu, Cobalt-iron mixed-metal-organic framework (Co_3Fe-MMOF) with high oxidase mimicking activity for sensitive colorimetric detection of glutathione, J. Food Compos. Anal. 122 (2023) 105472. https://doi.org/10.1016/j.jfca.2023.105472

[2] Y. H. Gu, J. P. Han, N. Zhang, W. S. Yan, Y. Guo, H. Y. Tan, C. Y. Yang, F. K. Wang, H. Q. Yao, Bimetallic Cu@ Co-MOFs mimic peroxidase for colorimetric detection of glutathione, ACS Appl. Nano Mater. 7(21) (2024) 24683-24696. https://doi.org/10.1021/acsanm.4c04563

[3] X. W. Zhang, J. Wang, N. Chang, Y. Yang , Y. Q. Li, Q. Wei, C. Ni, W. Y. Song, M. Y. Ma, X. Feng, R. H. Fan, Cu-BTC Derived Mesoporous CuS Nanomaterial as Nanozyme for Colorimetric Detection of Glutathione, Molecules 29(9) (2024) 2117. https://doi.org/10.3390/molecules29092117

[4] W. Shi, X. Y. Wang, Z. P. Yang, J. Yang, X. Y. Fu, X. X. Wang, Sr-doped MnO_2 with enhanced dual-enzyme mimetic activity for colorimetric detection of glutathione and 2,4-dichlorophenol, Microchem. J. 212 (2025) 113166. https://doi.org/10.1016/j.microc.2025.113166

[5] N. Kumar, H. Singh, A. Deep, M. Khatri, N. Bhardwaj, Smartphone-assisted colorimetric detection of glutathione in food and pharmaceutical samples using MIL-88A (Fe) [J], Spectrochim. Acta A 326 (2025) 125297. https://doi.org/10.1016/j.saa.2024.125297

[6] Y. Han, X. H. Tang, X. Y. Wu, H. Y. Shi, L. Huang, L. Wei, M. M. Li, Y. Zhang, Single-atom Co-N-C nanozymes with excellent oxidase-like activity for colorimetric detection of L-cysteine, Spectrochim. Acta A 332 (2025) 125778. https://doi.org/10.1016/j.saa.2025.125778

[7] X. Yao, H. Yang, Q. M. Liang, Z. D. Wei, Y. S. Zhang, L. Wang, J. W. Sun, Synergistic Nanozyme Platform Based on Interpenetrated POMOF and g-C_3N_4 for Colorimetric Determination of H_2O_2 and L-Cys, J. Mol. Struct. 1347 (2025) 143352. https://doi.org/10.1016/j.molstruc.2025.143352

[8] X. C. Deng, J. W. Zhao, Y. Ding, H. L. Tang, F. N. Xi, Iron and nitrogen co-doped graphene quantum dots as highly active peroxidases for the sensitive detection of L-cysteine, New Journal of Chemistry, 45(40) (2021) 19056-19064. https://doi.org/10.1039/d1nj03559b

[9] W. Liu, K. L. Wang,Y. You, J. F. Shangguan, M. J. Yuan, S. Y. Wang, A new colorimetric assay based on an assembly of gold nanoparticles and gold nanoclusters for Ag^+ and L-cysteine detection, New J. Chem. 49(31) (2025) 13369-13375. https://doi.org/10.1039/d5nj01702e

[10] R. Zhang, S. H. Zhang, J. H. Lu, Y. Wu, J. J. Zhao, Z. J. Wang, Polydopamine-coated bimetallic ZIF derivatives as a H_2O_2-free oxidase mimetic for the colorimetric sensing of L-cysteine, New J. Chem. 48(10) (2024) 4437-4445. https://doi.org/10.1039/d3nj05036j