Supporting Information for

Zn-Y dual atomic sites catalyst featuring metal-metal interactions as a nanozyme with peroxidase-like activity

Xiangyuan Jin,[1+] Xiaowei Feng,[1+] Guo Wang,[1*] Renjian Tan,[2] Yi Peng,[3] Lirong Zheng,[4] Wenxing Chen,[5*] Zhengbo Chen[1*]

[1]Department of Chemistry, Capital Normal University, Beijing 100048, China.

[2]Department of Chemistry, University College London, 20 Gordon Street, London WC1H0AJ, UK

[3]Department of Chemistry, Wayne State University, Detroit, Michigan, 48202, United States

[4]Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, China

[5]Energy & Catalysis Center, School of Materials Science and Engineering, Beijing Institute of Technology, Beijing100081, China

E-mail: czb979216@sina.com, wxchen@bit.edu.cn, wangguo@mail.cnu.edu.cn

†These authors contribute this work equally

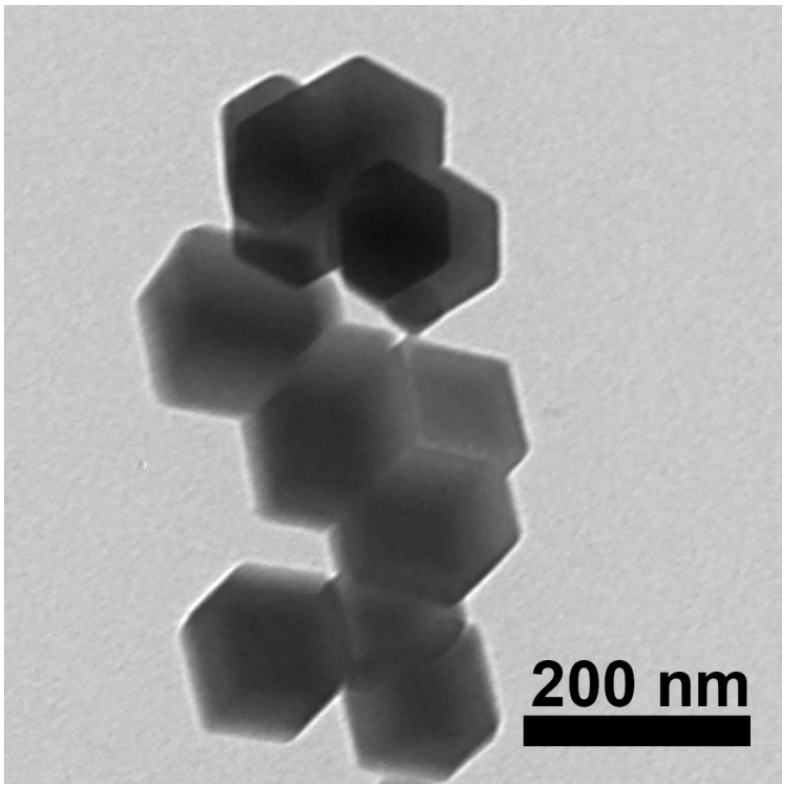

Figure S1. TEM image of $Y_{0.4}$@ZIF-8.

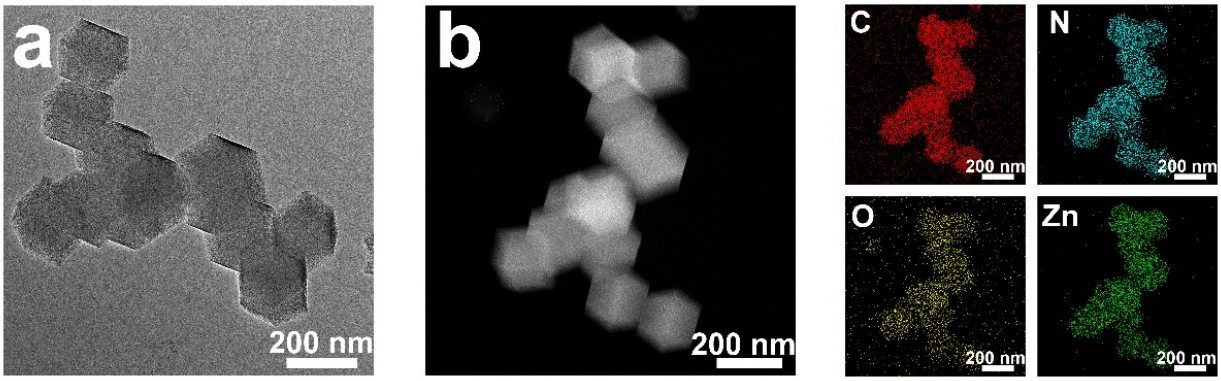

Figure S2. TEM images of Zn-SACs/NC and corresponding EDX Mapping images.

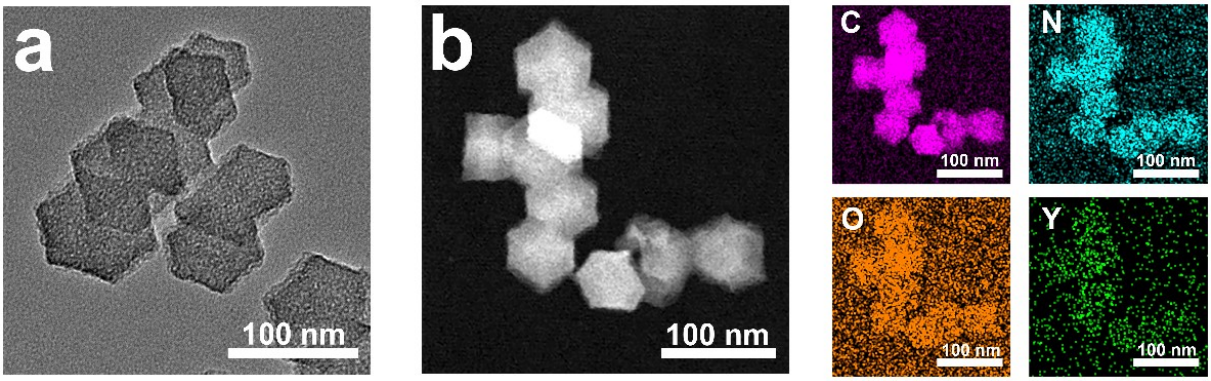

Figure S3. TEM images of Y-SACs/NC and corresponding EDX Mapping images.

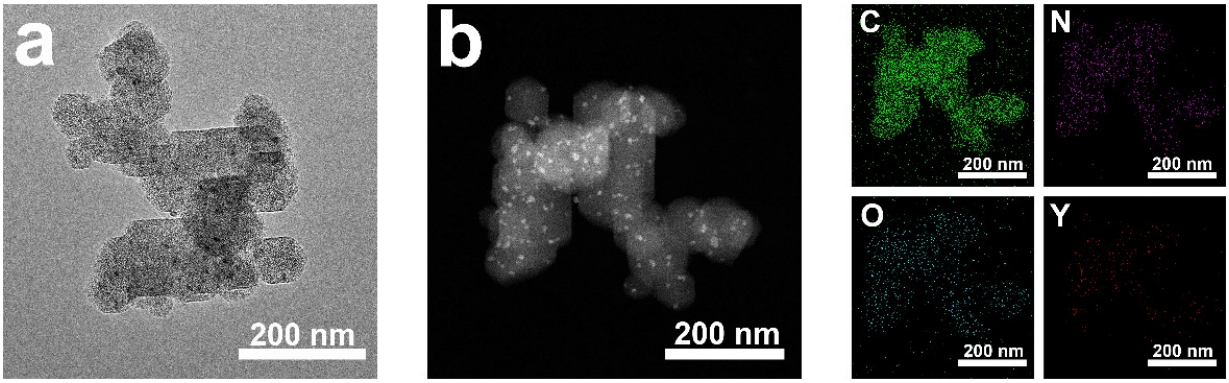

Figure S4. TEM images of $Y_{0.8}$-NC and corresponding EDX Mapping images.

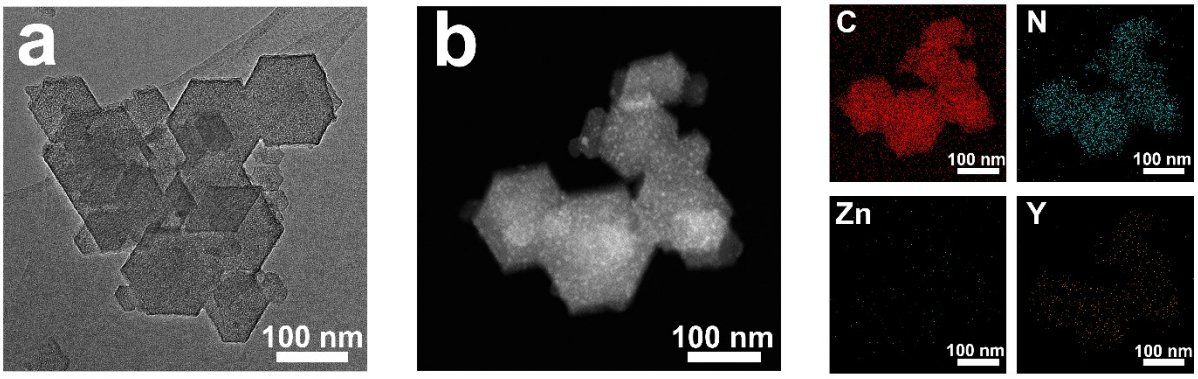

Figure S5. TEM images of Y_1-Zn-NC and corresponding EDX Mapping images.

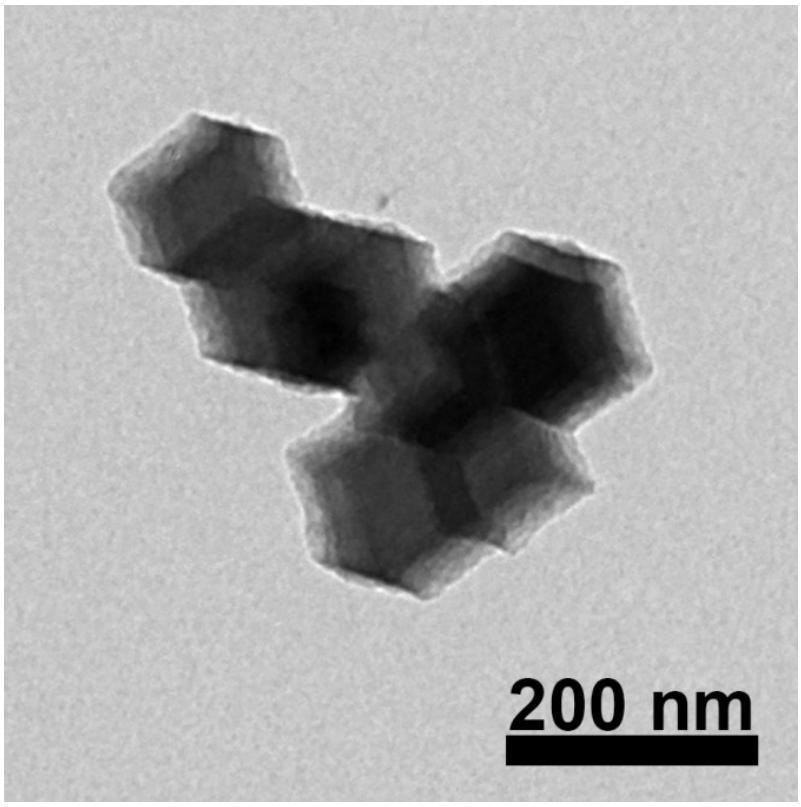

Figure S6. TEM images of NC.

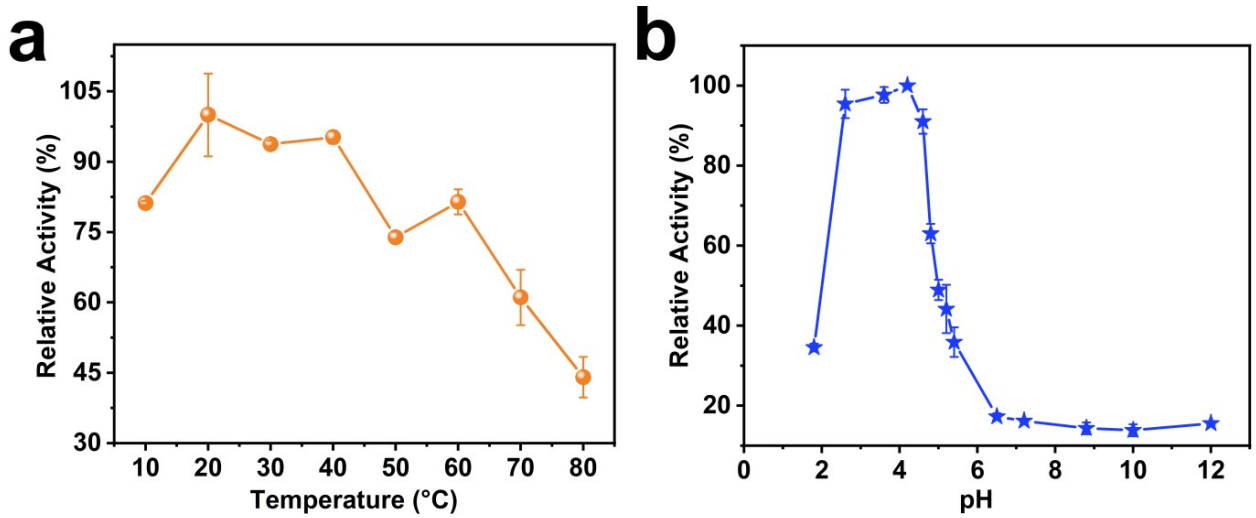

Figure S7. Relative activity for ZnY-DACs/NC as a function of (a) temperature and (b) pH.

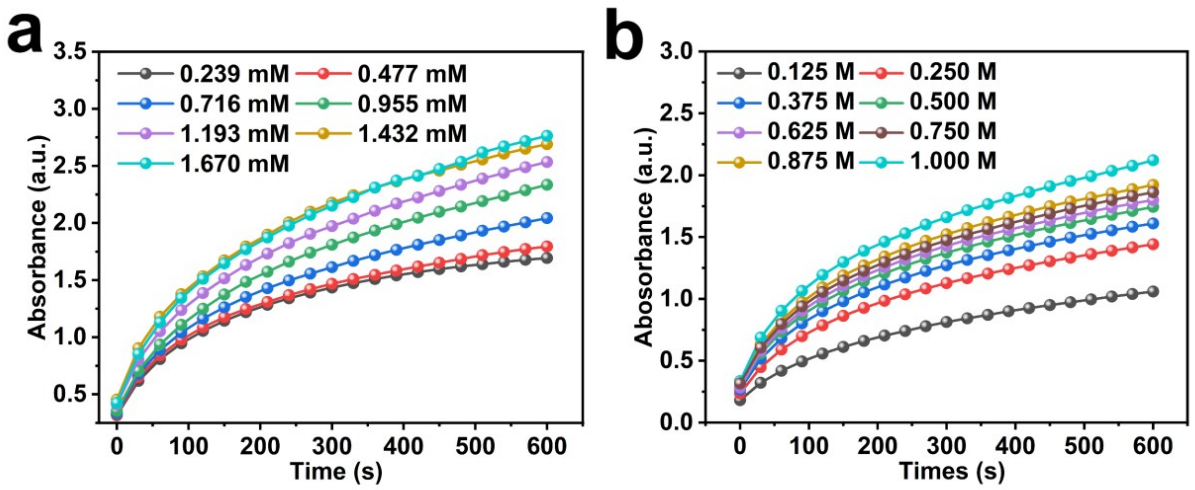

Figure S8. Absorbance changes as a function of time based on the oxidation of TMB by H_2O_2 catalyzed by ZnY-DACs/NC byusing different concentrations of TMB or H_2O_2. As the substrate (TMB or H_2O_2) increases, the initial reaction rate accelerates.

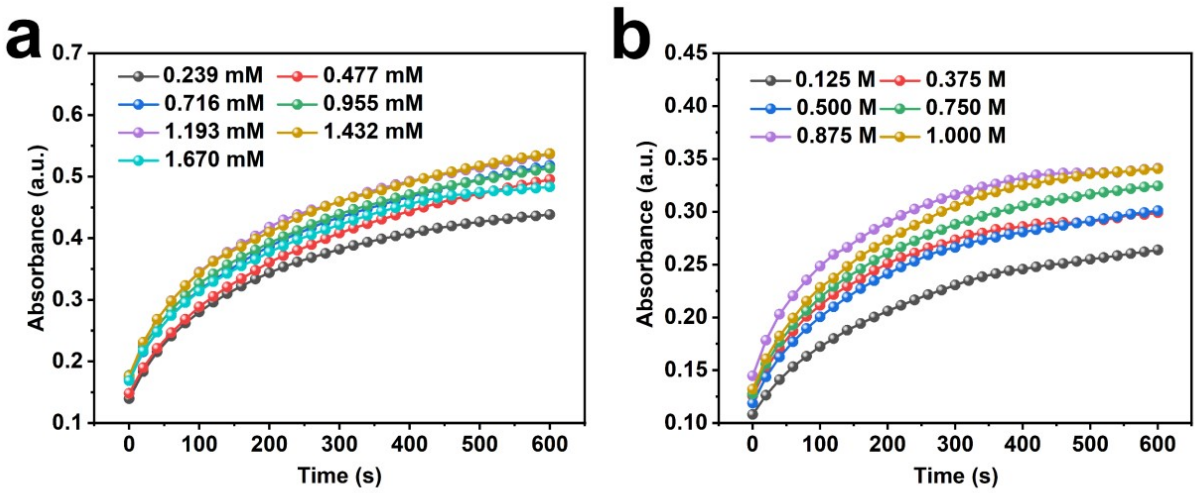

Figure S9. Absorbance changes as a function of time based on the oxidation of TMB by H_2O_2 catalyzed by Y-SACs/NC through using different concentrations of TMB or H_2O_2. As the substrate (TMB or H_2O_2) increases, the initial reaction rate accelerates.

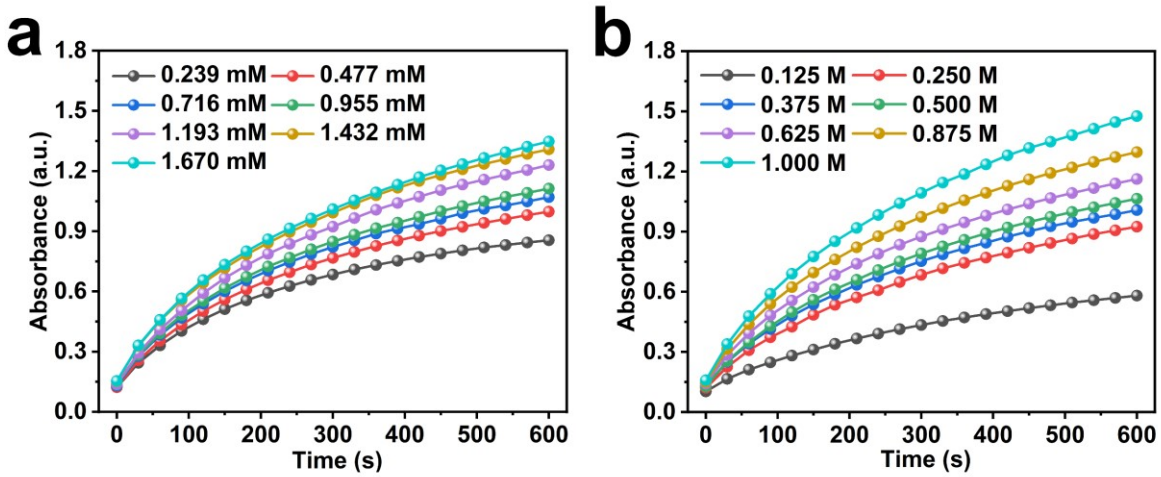

Figure S10. Absorbance changes as a function of time based on the oxidation of TMB by H_2O_2 catalyzed by $Y_{0.8}$-NC through using different concentrations of TMB or H_2O_2.

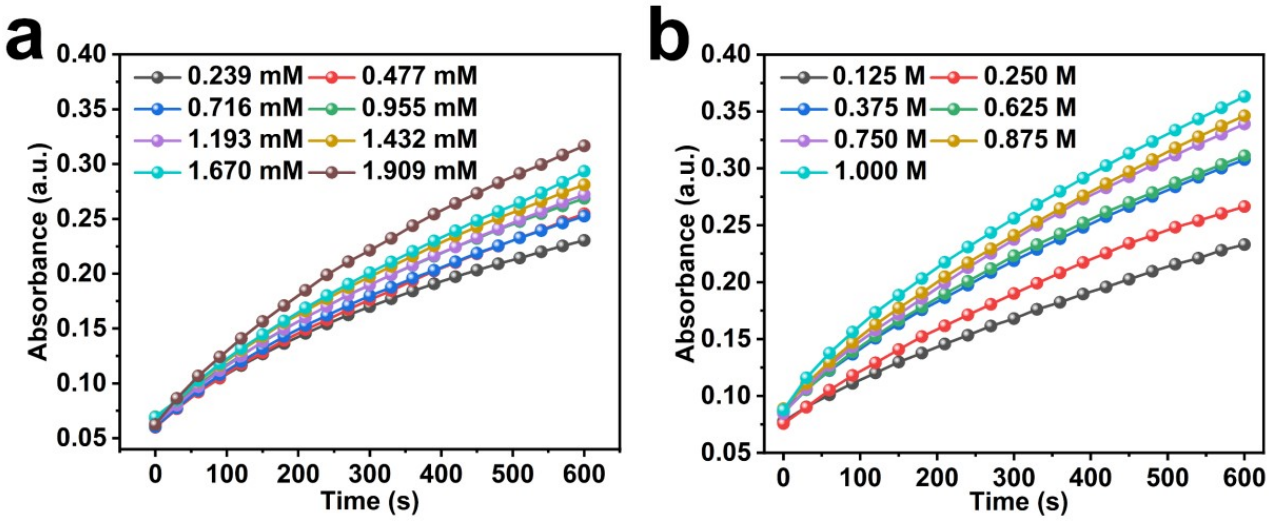

Figure S11. Absorbance changes as a function of time based on the oxidation of TMB by H_2O_2 catalyzed by Y_1-Zn-NC through using different concentrations of TMB or H_2O_2.

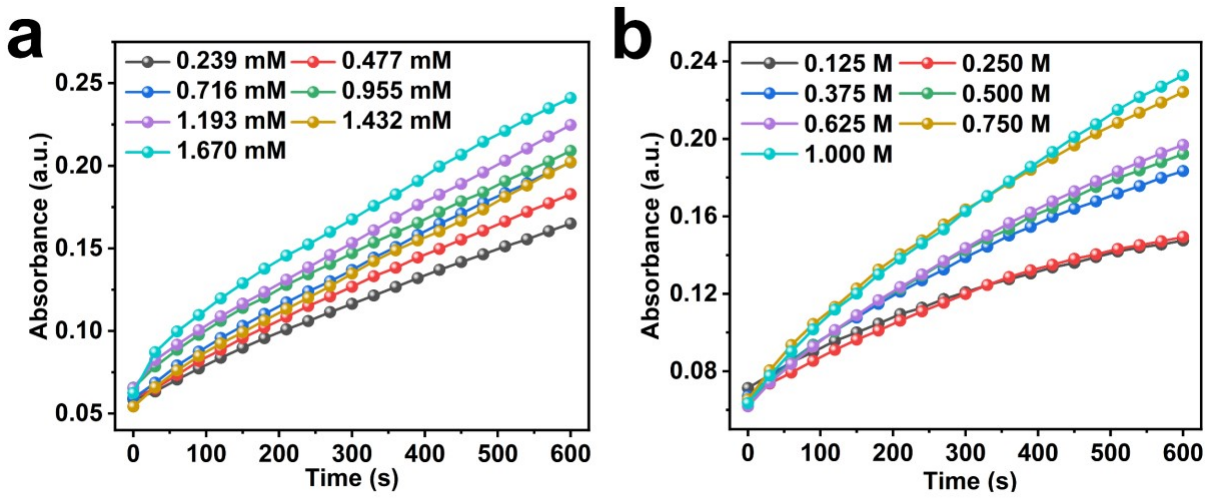

Figure S12. Absorbance changes as a function of time based on the oxidation of TMB by H_2O_2 catalyzed by Zn-SACs/NC through using different concentrations of TMB or H_2O_2.

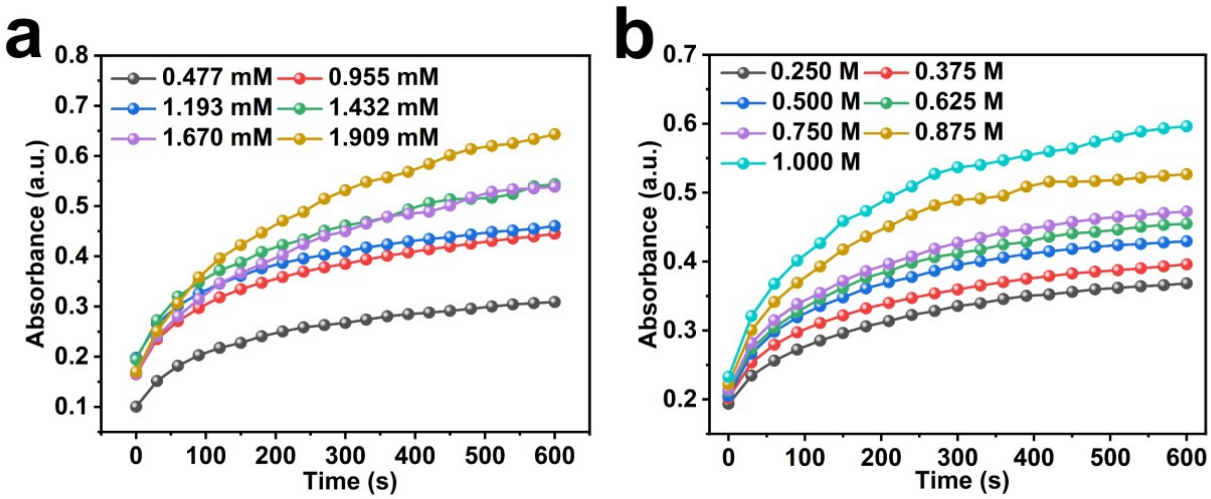

Figure S13. Absorbance changes as a function of time based on the oxidation of TMB by H_2O_2 catalyzed by NC through using different concentrations of TMB or H_2O_2.

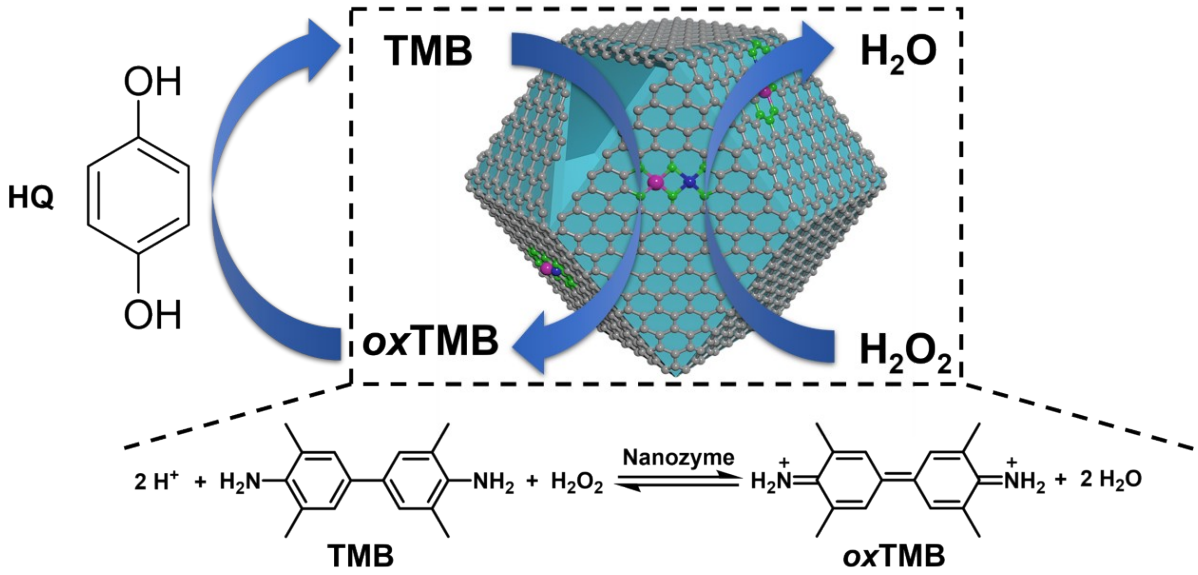

Figure S14. Schematic illustration of the colorimetric sensing platform for hydroquinone detection based on (ZnY-DACs/NC)-TMB-H_2O_2 reaction system.

Table S1. Structural parameters extracted from the Zn and Y K-edge EXAFS fitting. (S_0^2=0.85)

Sample	Scattering pair	CN	*R*(Å)	σ²(10⁻³Å²)	Δ*E*₀(eV)	R factor
ZnY-DACs/NC	Zn-N	4.0	1.99	5.1	1.0	0.005
	Zn-Y	1.0	2.59	5.2	1.0	
Zn-SACs/NC	Zn-N	3.9	2.02	5.5	1.0	0.006
ZnY-DACs/NC	Y-N	4.2	2.01	5.9	1.5	0.009
	Y-Zn	1.1	2.61	4.6	1.5	
Y-SACs/NC	Y-N	4.1	1.97	4.6	1.5	0.007

S_0^2 is the amplitude reduction factor; CN is the coordination number; *R* is interatomic distance (the bond length between central atoms and surrounding coordination atoms). σ^2 is Debye-Waller factor (a measure of thermal and static disorder in absorber-scatterer distances); ΔE_0 is edge-energy shift (the difference between the zero kinetic energy value of the sample and that of the theoretical model). *R* factor is used to value the goodness of the fitting.

Error bounds that characterize the structural parameters obtained by EXAFS spectroscopy were estimated as CN ± 20%; *R* ± 1%; σ^2 ± 20%; ΔE_0 ± 20%.

Table S2. K_m and V_m values for ZnY-DAC/NC and its reference samples with TMB and H_2O_2 as the substrates.

Nanozyme	TMB as the substrate		H_2O_2 as the substrate	
	K_m(mM)	V_m(10^{-4} mM·s^{-1})	K_m(M)	V_m(10^{-7} M·s^{-1})
ZnY-DACs/NC	0.1003	4.77	0.2640	4.69
$Y_{0.8}$-NC	0.1015	1.76	0.3873	2.51
Y_1-Zn-NC	0.1092	0.167	0.1837	0.275
Y-SACs/NC	0.0657	0.800	0.0699	0.425
Zn-SACs/NC	0.4109	0.168	0.3091	0.156
N-C	0.5316	1.27	0.3837	1.34