

Electronic Supporting Information

A highly sensitive Zr-MOFs mediated multi-enzyme cascade platform for the colorimetric and fluorescent dual-signal determination of sarcosine

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Reagents

The chemical reagents used in the experiments are of analytical grade without further purification. The deionized water used in this experiment has a resistivity greater than $18 \text{ M}\Omega \text{ cm}^{-1}$. ZrCl_4 , 2,2'-bipyridine-5,5'-dicarboxylic acid and P-phenylenediamine were purchased from Sinopharm Chemical Reagent (Shanghai) Co. TMB, potassium periodate was obtained from Guangfu Reagent (Tianjin) Co., Ltd. Hydrogen peroxide (H_2O_2), N,N-dimethylformamide (DMF), sodium acetate (NaAc), acetic acid (HAc) and Methanol were obtained from Beijing Chemical Works (Beijing). NaCl, ZnCl_2 , KIO_4 , MgSO_4 and KBr were purchased from Tianjin Guangfu Institute of Fine chemicals. Threonine, glycine, lysine, tyrosine, arginine, proline, histidine, asparagine, glucose, urea were purchased from Sangon Biotech (Shanghai). Inorganic salt, and Sox were purchased from Beijing Chemical Works (Beijing). And the configured solutions were all stored at 4°C .

Instrumentation

Fluorescence spectra were collected with a Shimadzu RF-5301 PC spectrofluorophotometer (Shimadzu Co. Ltd, Kyoto, Japan). UV-vis absorption spectra were collected on a Varian GBC Cintra 10e UV-visible Spectrophotometer (Shimadzu Co.Ltd, Kyoto, Japan). Powder X-ray diffraction (XRD) patterns were obtained using a D/max 2550 VB/PC diffractometer with $\text{Cu K}\alpha$ radiation ($\lambda = 1.5406 \text{ \AA}$) (Rigaku Corporation, Japan). X-ray photoelectron spectroscopy (XPS) spectra were obtained by a Thermo ESCALAB 250 electron energy spectrometer with

standard Al K alpha excitation (Shanghai, China). Analyser Mode: CAE (Constant analyzer energy) mode; Spot size: 500 μ m; Pass energy: 100.0 eV (survey scan)/30.0 eV (narrow scan); Energy Step Size: 1.00 eV (survey scan)/0.05 eV (narrow scan). All pH measurements throughout the study were performed with a PHS-3C pH meter (INESA Scientific Instrument Co. Ltd, Shanghai, China). Transmission Electron Microscopy (TEM) was obtained by Hitachi H-800 electron microscope using an accelerating voltage of 300 KeV (<http://www.hitachi.com.cn/>). Fluorescent tags of co-immobilized SOX and HRP were performed on a FV1200 laser scanning confocal microscope (Olympus, China), by using fluorescein isothiocyanate (FITC) and rhodamine B (RhB) as fluorescent markers. Fourier transform infrared (FT-IR) spectra were recorded through a Thermo Nicolet 360 FTIR spectrometer.

Synthesis of CDs

Typically, 40 mg KIO₄ was dissolved in a 10 mL experimental ethanol solution containing 10 mg of p-phenylenediamine. Subsequently, the resulting mixture was moved to a Teflon-lined autoclave and heated to 180 °C for 120 minutes. The obtained solution was processed by a dialysis bag (MWCO 10000 Da) in ethanol for 10 h.

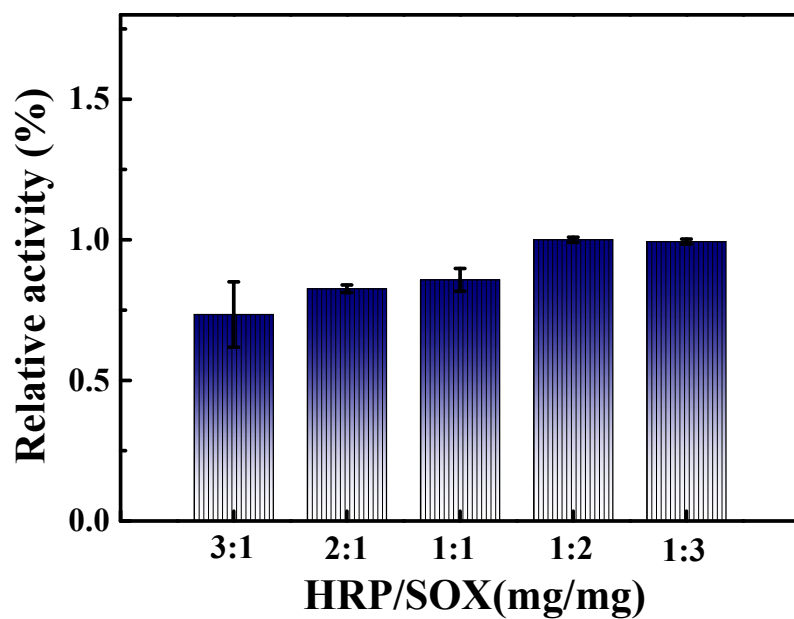


Fig. S1 The Effect of different equivalent ratio of HRP/SOX on Zr-MOFs@SOX@HRP.

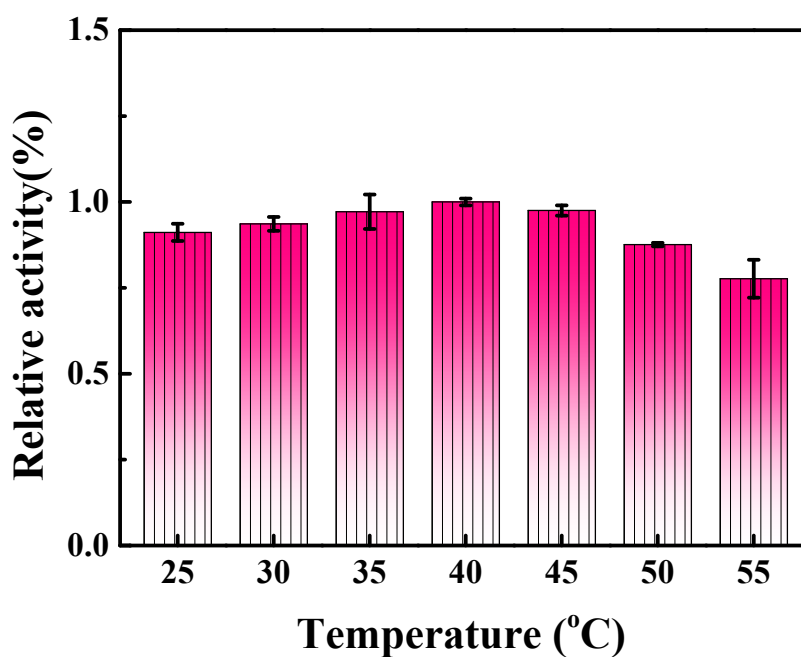


Fig. S2 The Effect of synthesis temperature on Zr-MOFs@SOX@HRP.

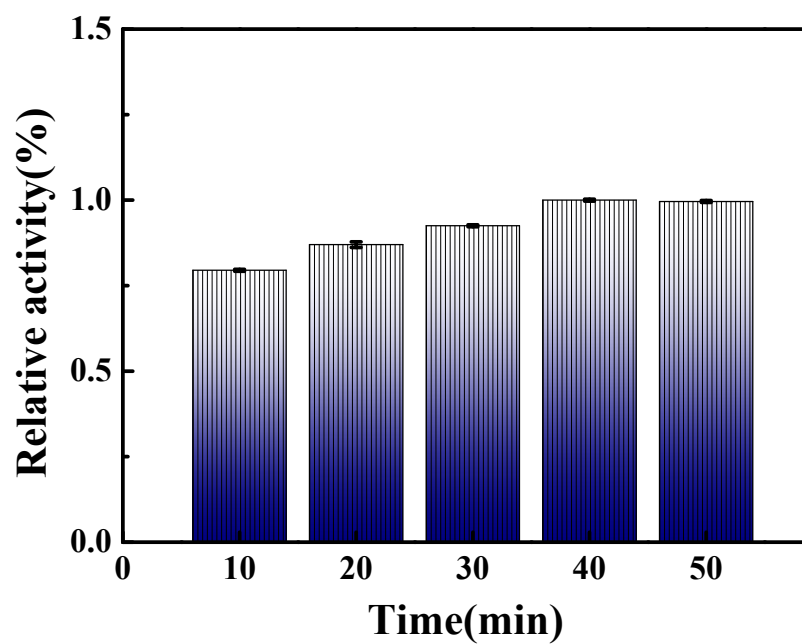


Fig. S3 The Effect of synthesis time on Zr-MOFs@SOX@HRP.

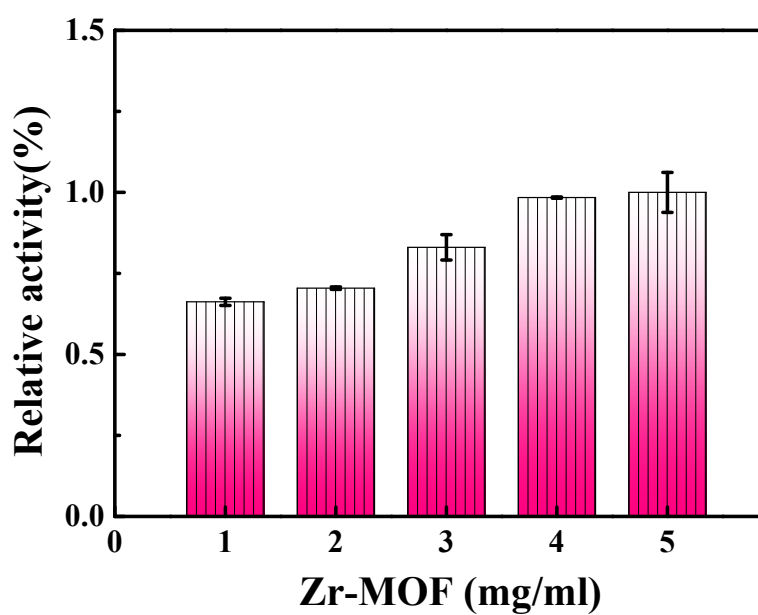
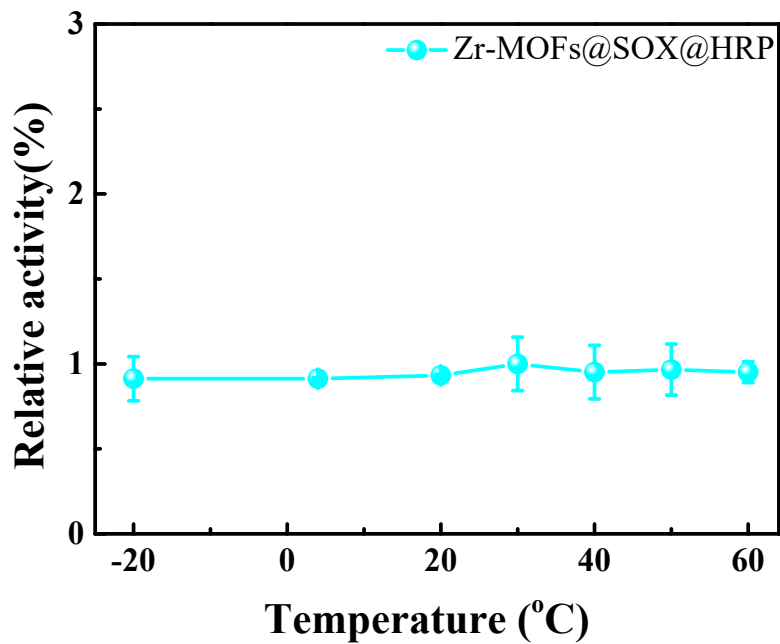


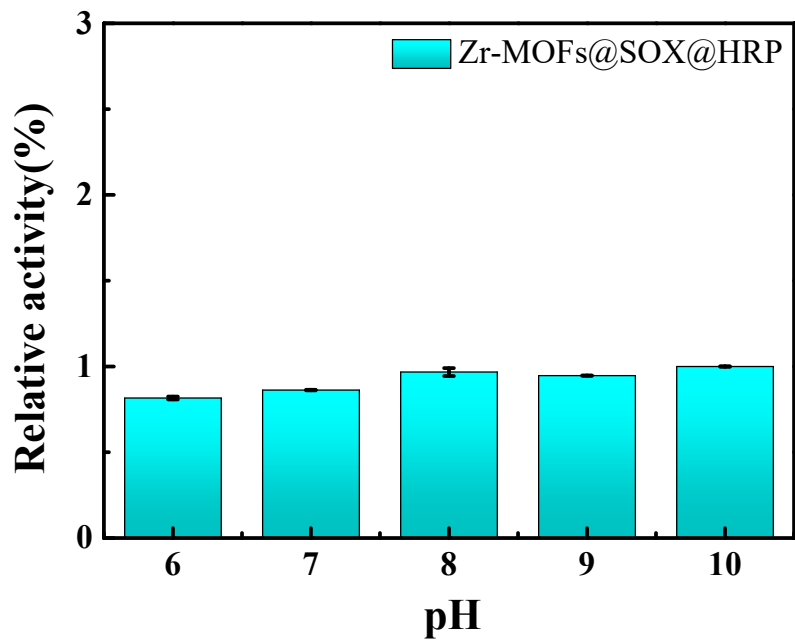
Fig. S4 The Effect of concentration of Zr-MOFs on Zr-MOFs@SOX@HRP.



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2 **Fig. S5** The relative activity of Zr-MOFs@SOX@HRP stored at different
3 temperatures.

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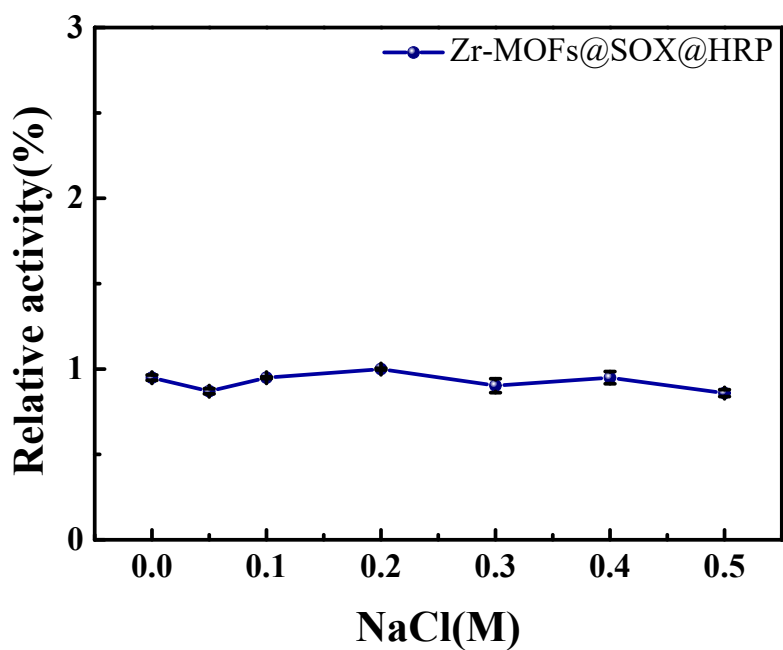


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6 **Fig. S6** The relative catalytic activity of Zr-MOFs@SOX@HRP stored at different
7 pH.

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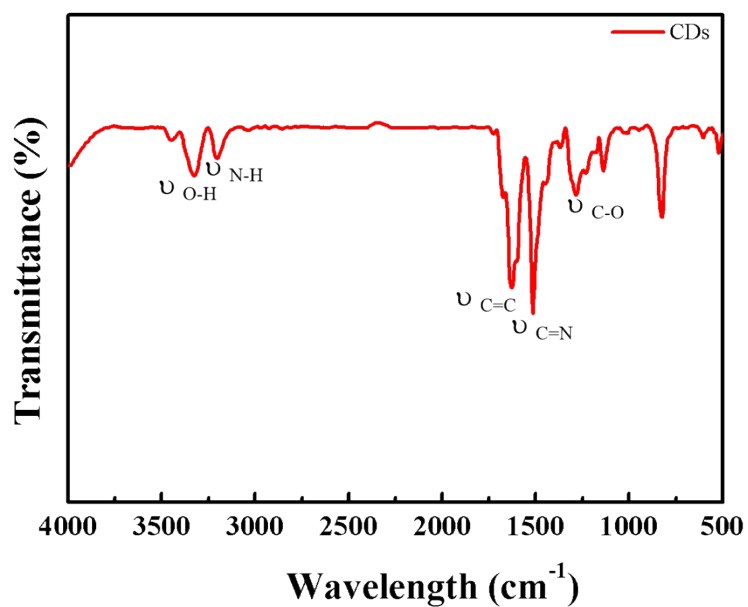
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3 **Fig. S7** The relative activity of Zr-MOFs@SOX@HRP stored at different
4 concentration of NaCl.

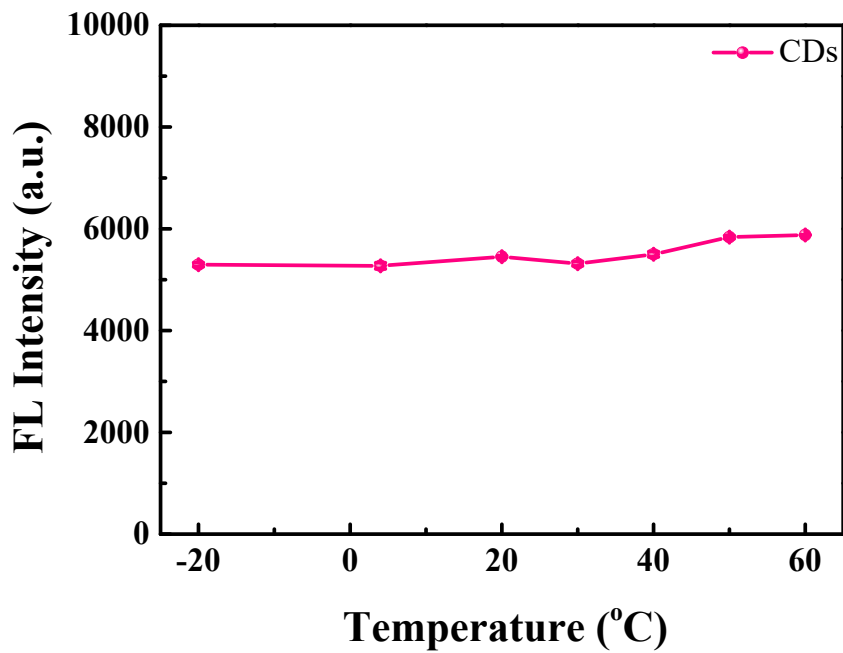
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7 **Fig. S8** The FTIR spectra of CDs.

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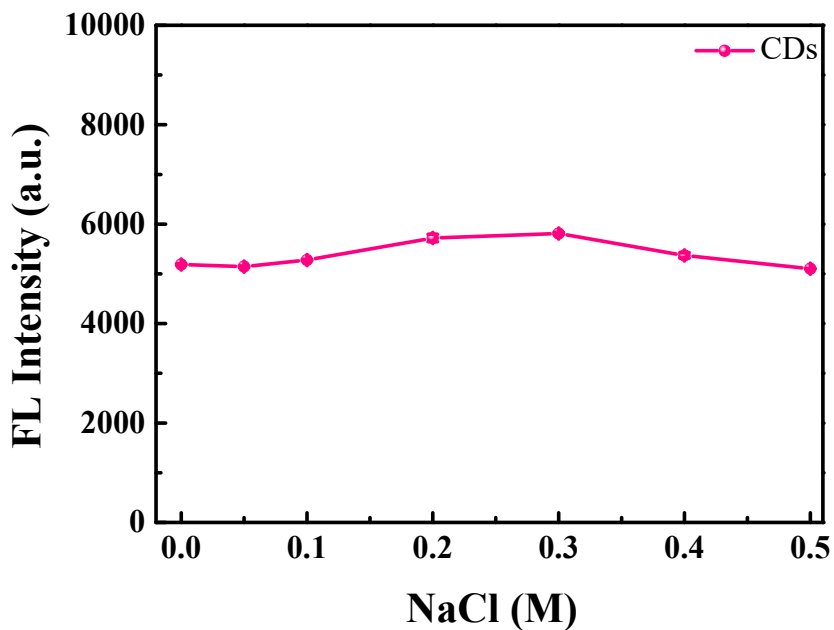


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2 **Fig. S9** The fluorescence intensity of CDs stored at different temperatures.

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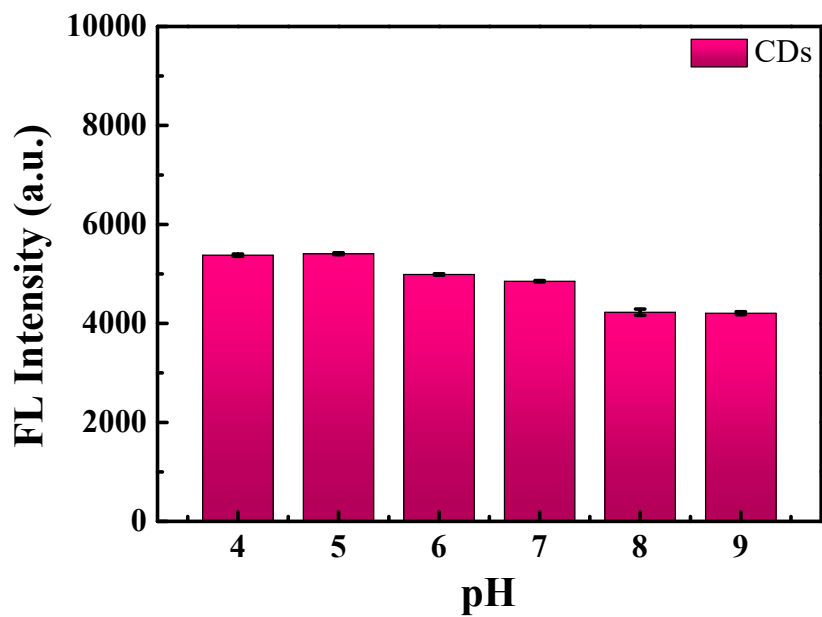


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6 **Fig. S10** The fluorescence intensity of CDs stored at different concentration of NaCl.

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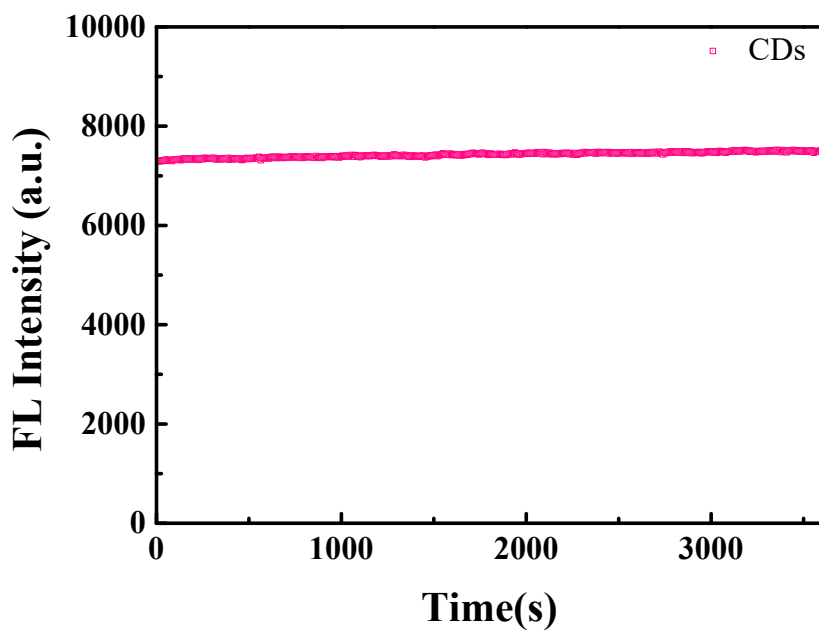


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2 **Fig. S11** The fluorescence intensity of CDs stored at different pH.

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6 **Fig. S12** The photobleaching property on the fluorescence intensity variation of CDs

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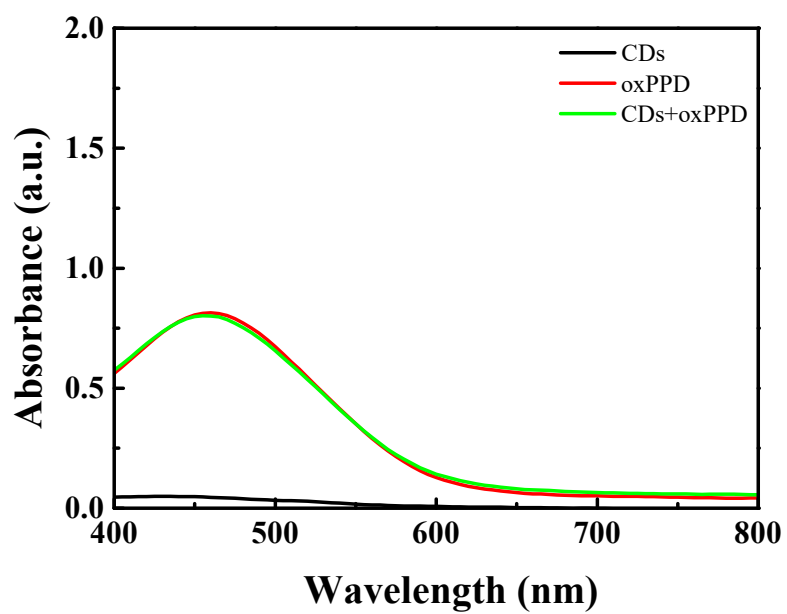


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2 **Fig. S13** The figure of PPD (left) and oxPPD (right) solution under daylight.

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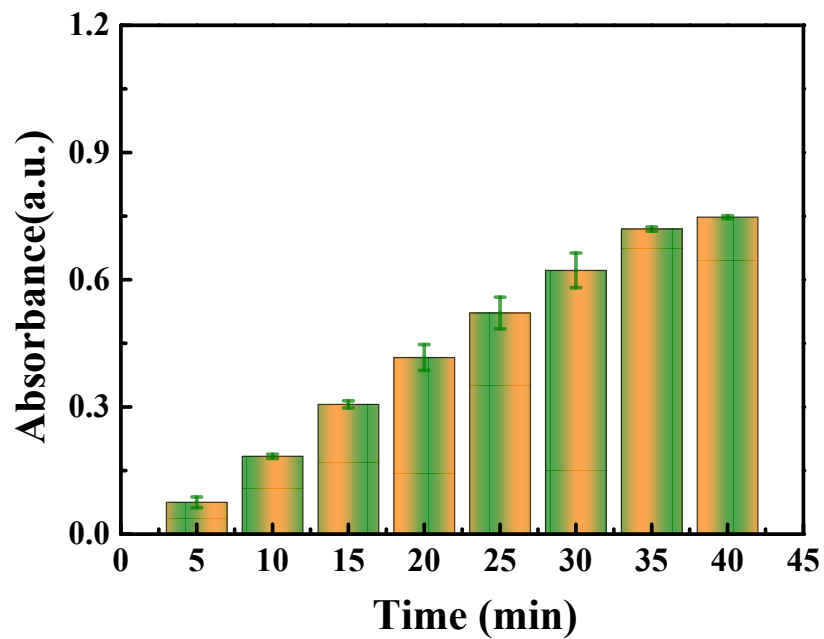
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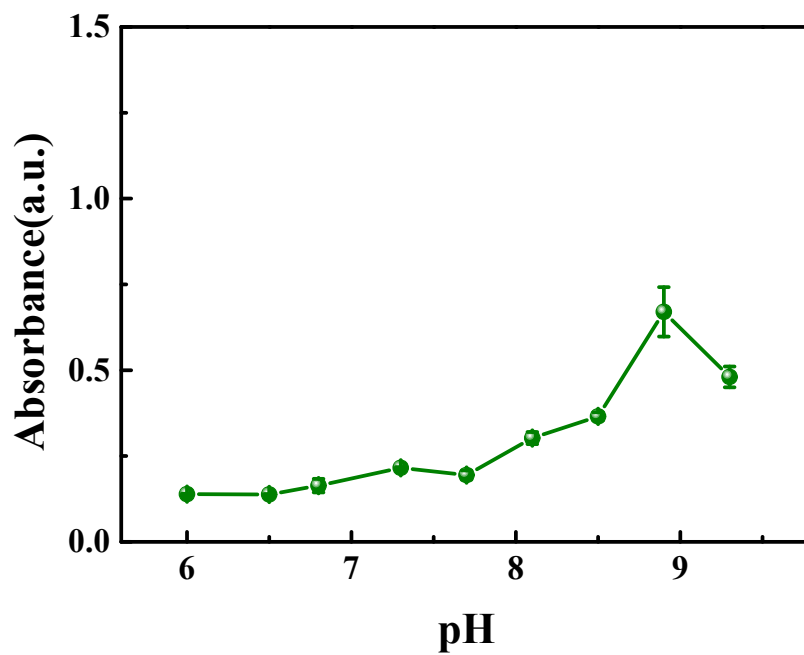
7 **Fig. S14** UV-vis absorption spectra of CDs, oxPPD and CDs+oxPPD.



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2 **Fig. S15** The effect of reaction time on the absorption intensity of the Zr-
 3 MOFs@SOX@HRP/SO/PPD system.

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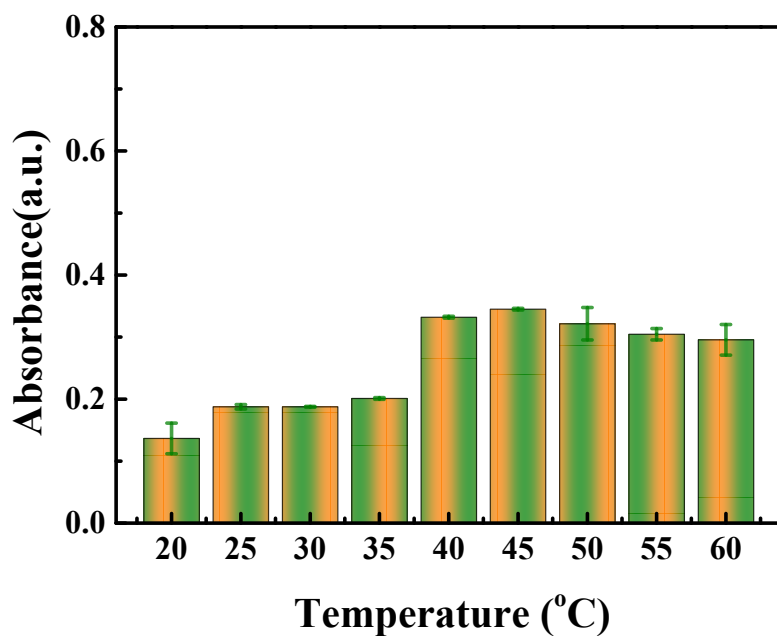


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6 **Fig. S16** The effect of reaction pH on the absorption intensity of the Zr-
 7 MOFs@SOX@HRP/SO/PPD system.

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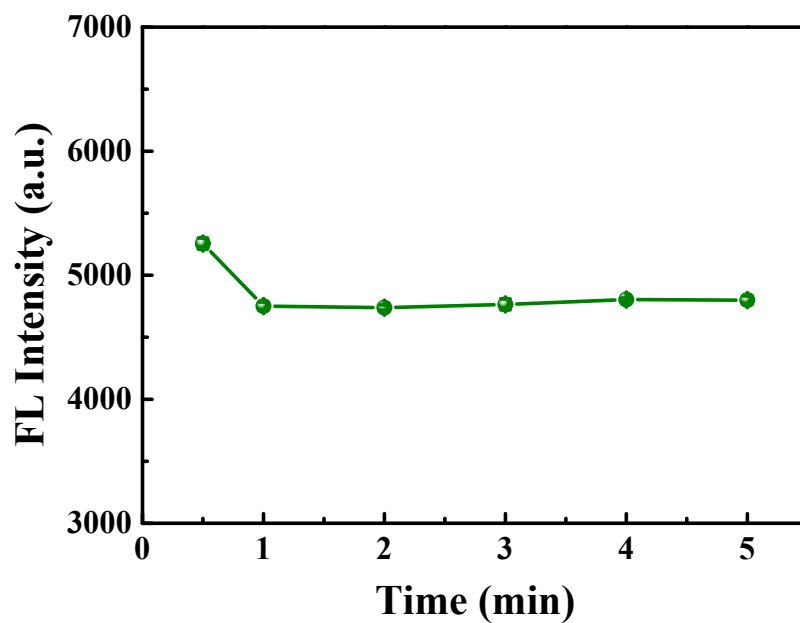
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2 **Fig. S17** The effect of reaction temperature on the absorption intensity of the Zr-
 3 MOFs@SOX@HRP/SO/PPD system.

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6 **Fig. S18** The effect of adding CDs to Zr-MOFs@SOX@HRP/SO/PPD system on
 7 reaction time.

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1 **Table S1** Comparison of analytical performances of various methods for sarcosine
 2 detection.

Material	Method	Linear range(μM)	LOD(μM)	Ref.
CNT/Pt	Electrochemical	6–750	6	[1]
Fe-doped g-C ₃ N ₄	Colorimetry	10-500	3.6	[2]
SiO ₂ @TiO ₂ /PDI-OH	Colorimetry	0.3–1000	0.12	[3]
CuInS ₂	Photoelectrochemical	10-1000	8	[4]
MIP monolithic fibre	Gas Chromatograph	11.2-1120	4.1	[5]
Ag NCs	Fluorescence	200-1600	10.33	[6]
CuT@N NS	Fluorescence	7.5–1100	4.69	[7]
BCDs+MnO ₂ NSs	Fluorescence	1–80	0.36	[8]
Zr-	Colorimetry	0.5-150	0.44	Our work
MOFs@SOX@HRP/C	Fluorescence	0.5-200	0.21	
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4 Reference

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