

Supporting information

Zirconium and vanadium bimetallic organic framework nanozyme for bioenzymes-free colorimetric and photothermal dual-mode direct detection of organophosphorus pesticides

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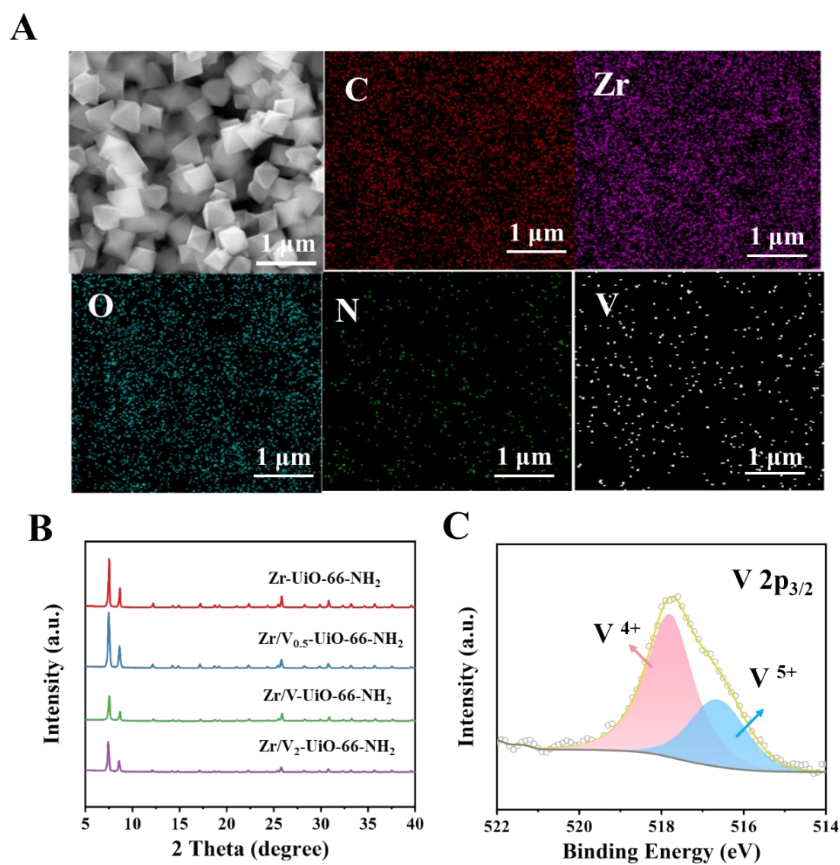


Figure S1. (A) The SEM image of Zr/V-UiO-66-NH₂ MOFs and the related EDS mapping; (B) the XRD patterns of Zr/V_x-UiO-66-NH₂ MOFs at different Zr/ V ratios. (C) High-resolution XPS of V 2p_{3/2}.

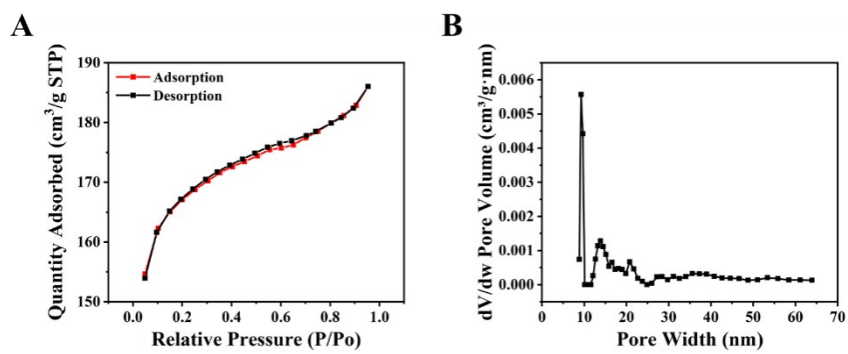


Figure S2. (A) The N₂ adsorption-desorption isotherm and (B) the pore size distribution of Zr/V-UiO-66-NH₂.

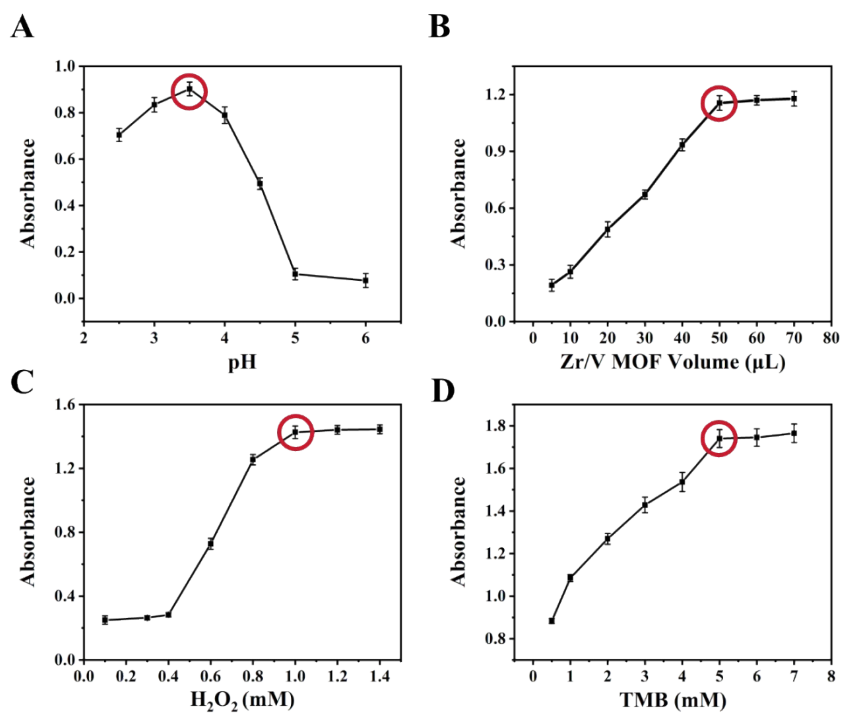


Figure S3. The effect of the (A) pH value, (B) Zr/V-UiO-66-NH₂'s volume, (C) H₂O₂ concentration and (D) TMB concentration.

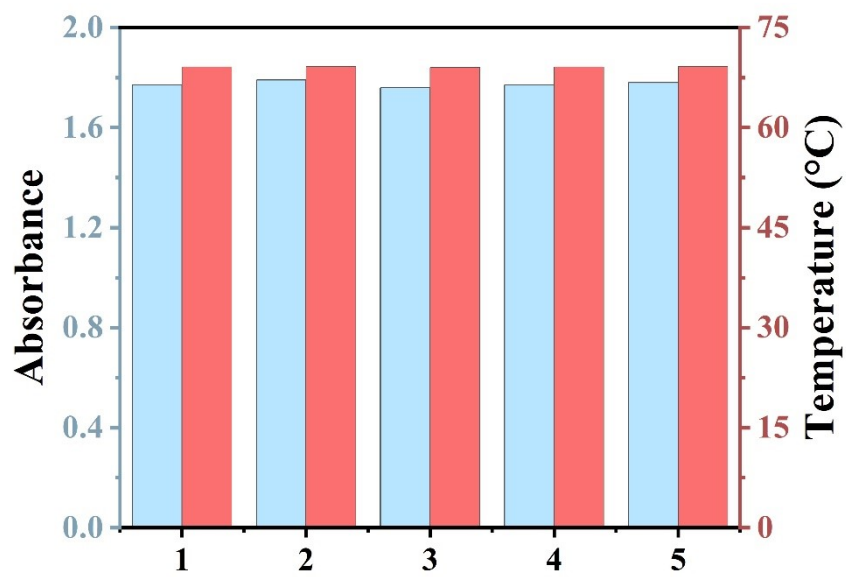


Figure S4. Colorimetric/photothermal signal stability of Zr/V-UiO-66-NH₂ in different batches.

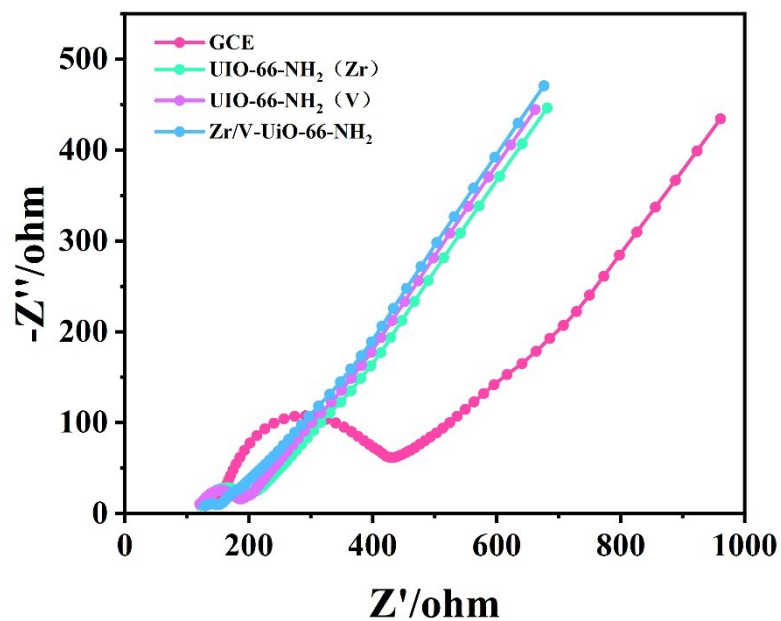


Figure S5. Electrochemical impedance spectroscopy of GCE, UIO-66-NH₂ (Zr), UIO-66-NH₂ (V) and Zr/V-UiO-66-NH₂.

Table S1. Comparison of K_m and V_{max} of Zr/V-UiO-66-NH₂ with other enzymes.

Enzymes	Substrate	K_m (mM)	V_{max} (10^{-8} Ms ⁻¹)	Ref.
MoSA-N3-C	TMB	0.79	11.2	1
	H ₂ O ₂	2	37.0	
Zr ₃ Fe ₃ O ₄ NPs	TMB	0.62	66.7	2
	H ₂ O ₂	45.99	5.56	
Zr-MOFs@Pt	TMB	0.34	9.98	3
	H ₂ O ₂	1.52	7.09	
V2O5-(Ce ³⁺ /Ce ⁴⁺)-MOF	TMB	0.35	5.33	4
	H ₂ O ₂	-	-	
MIL-88B(V)	TMB	1.49	9.32	5
	H ₂ O ₂	3.22	9.62	
UiO-66-TCPP	TMB	1.66	4.47	6
	H ₂ O ₂	0.42	1.26	
Zr/V-UiO-66-NH ₂	TMB	0.79	61.0	This work
	H ₂ O ₂	0.92	66.4	

Table S2. Comparison of different methods for OPs detection.

Sensor	Method	Bioenzymes	Linearity (ng mL ⁻¹)	Detection limit (ng mL ⁻¹)	Ref.
FeSA/FeNP	LSV	AChE	0.5-200	0.24	7
Cu/Ce-MOF-808	Colorimetry	AChE	900-4×10 ⁵	420	8
TPE-Fc/GSH-AuNC	Fluorescent	AChE	10-2000	2.05	9
MnO ₂ NSs	Photothermal	AChE	0.1-8000	1.01	10
Pt-Ni NPs	Colorimetry	AChE	5-200	1.2	11
MnO ₂ NSs/TH-[Ru(bpy) ₃] ²⁺	Fluorescent	AChE	0.1-8×10 ³	1.13×10 ⁻³	12
PCN-224-Mn	Photothermal	ACP	10-10 ⁴	1.01	13
	Colorimetry	ACP	5-10000	1.47	
Zr/V-UiO-66-NH ₂	Colorimetry	Free	0.05-1500	0.016	This work
	Photothermal		0.4-5000	0.13	

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