

Synthesis of Mesoporous CuO Hollow Sphere Nanozyme for Paper-based Hydrogen Peroxide Sensor

Synthesis of mesoporous CuO hollow sphere

Typically, F127 (0.2 g) was dissolved in the mixture of water (37 mL), ethanol (8 mL) and ammonia solution (0.35 mL, 25 wt%). TA (0.2 g in 8 mL of water) solution was then added to the above solution. Formaldehyde solution (3.8 mL, 3.7 wt%) was added to cross-link the polyphenol. After stirring for 24 hours, 2 mL of $\text{Cu}(\text{NO}_3)_2$ solution (containing 0.1 g of $\text{Cu}(\text{NO}_3)_2$) was added to the above solution. After another 24 h, the solution was transferred into an autoclave (100 mL) for hydrothermal treatment at 100 °C for 12 hours. The metal-polyphenol colloidal spheres were collected by centrifugation, washing and drying. Mesoporous CuO hollow sphere were obtained by calcination at 350 °C for 2 hours in air with a ramping rate of 2 °/min.

Characterization

Scanning electron microscopy (SEM) images were obtained on a Gemini SEM500. Transmission electron microscopy (TEM) images and selected area electron diffraction (SAED) patterns were taking using a JEM-F200. Nitrogen adsorption/desorption isotherms were measured with a Micromeritics Tristar 3020. X-ray diffraction (XRD) patterns were collected by a Bruker D8 Advance. X-ray photoelectron spectroscopy (XPS) spectra were recorded on a Kratos AXIS Ultra DLD system with Al $K\alpha$ radiation as an X-ray source.

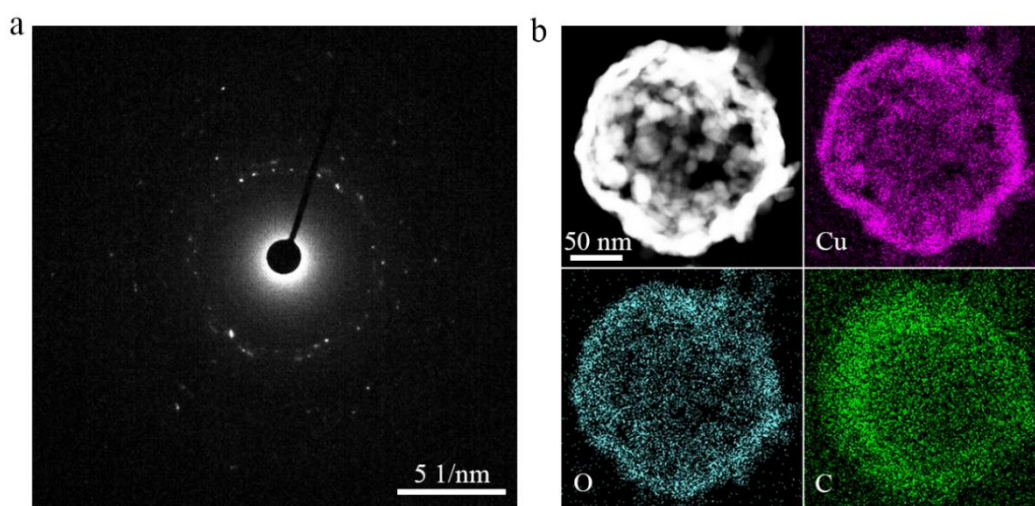


Figure S1. (a) Selected area electron diffraction (SAED) patterns. (b) STEM image and elemental mapping images of Cu-TA-350.

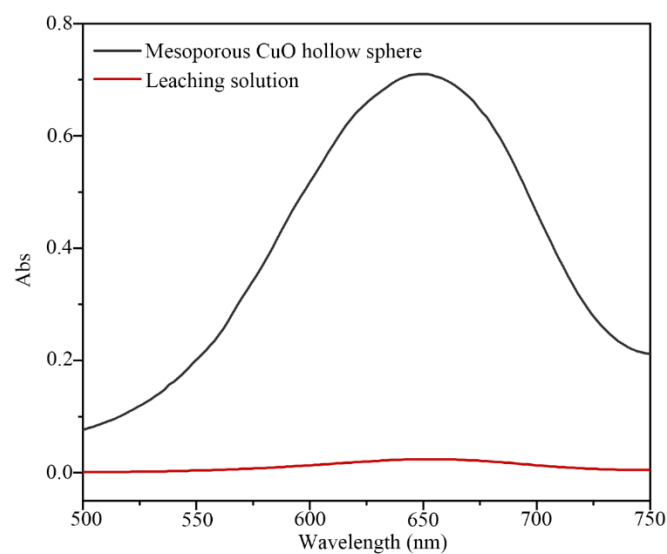


Figure S2. The catalytic activity of leaching solution and mesoporous CuO hollow sphere. The leaching solution was prepared by incubation of the Cu-TA-350 nanozyme in the buffer solution with a pH value of 5.0 for 30 min followed by removal of solid products.

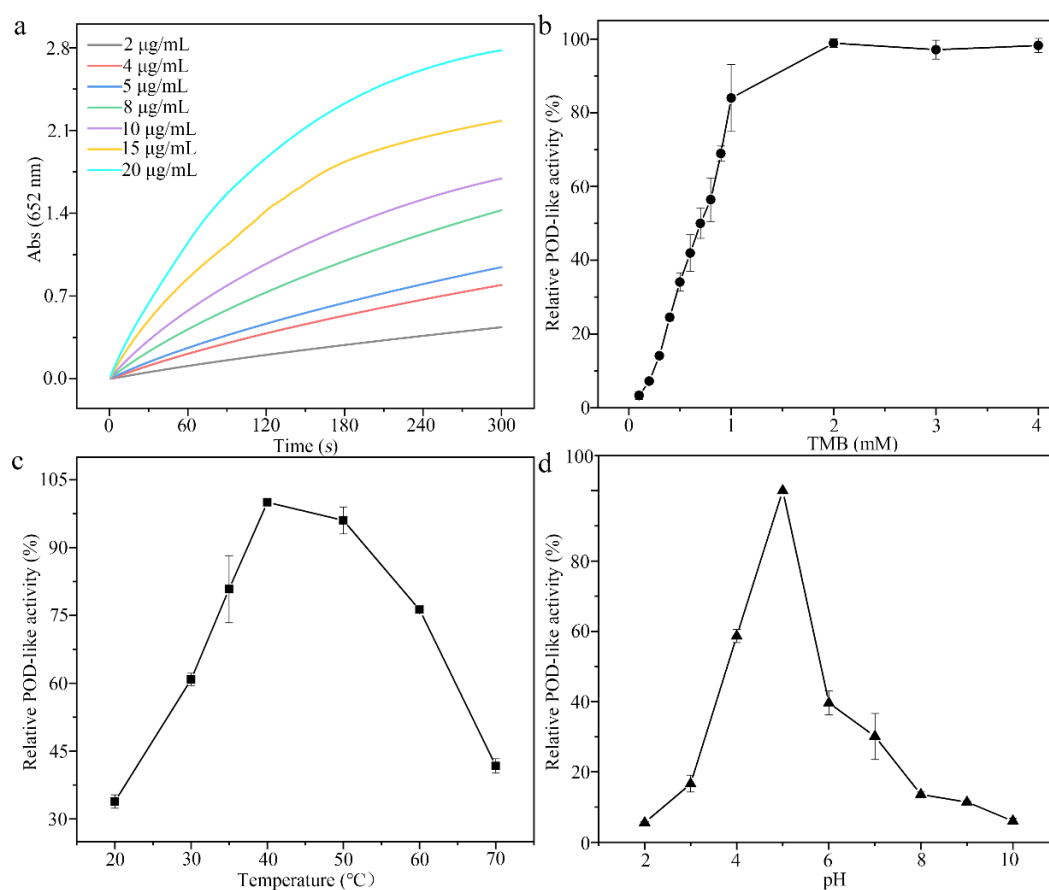


Figure S3. (a) Reaction-time curves of TMB colorimetric reactions in the present of different concentrations of Cu-TA-350 solution. (b-d) The relative POD-like activity at different conditions: (b) concentrations of TMB, (c) reaction temperature, (d) pH value in the reaction system.



Figure S4. The optical photographs of different concentrations of H₂O₂ (0-600 μM) reaction samples.

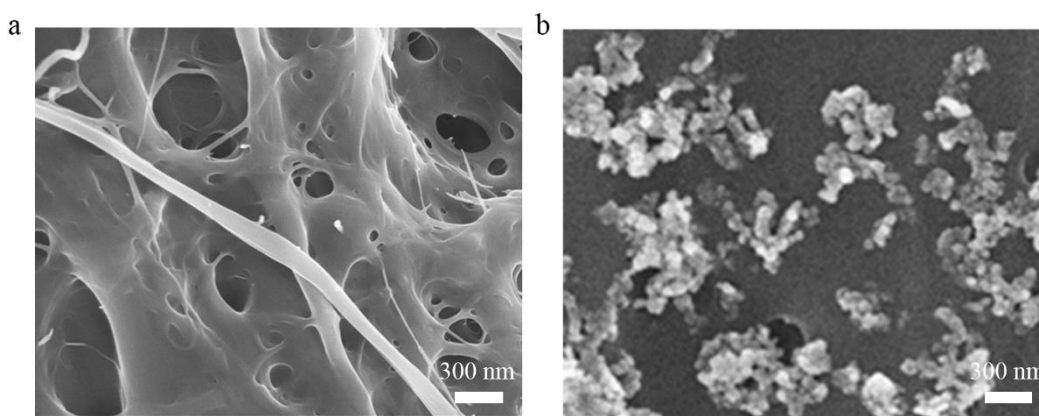


Figure S5. SEM images of paper substrate (a) without and (b) with the deposition of Cu-TA-350.

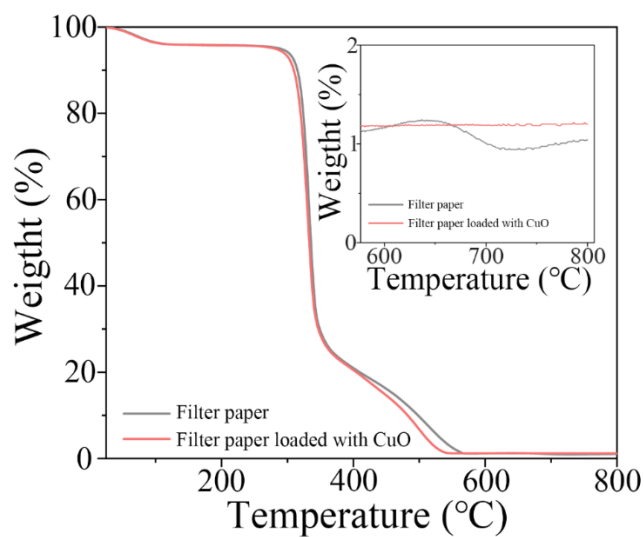


Figure S6. TG curves for filter paper and filter paper loaded with CuO-350 inset TG curves is a partial enlarged view.

Table S1. Comparison of the peroxidase-like activity of different nanomaterials.

Catalyst	K_m (mM)	V_{max} (10^{-4} mM s $^{-1}$)	refs
HRP	3.7	87.1	[1]
CuO	400	104.9	[2]
Fe ₃ O ₄	154	79.8	[3]
Co ₃ O ₄	140	121	[4]
Pure Cu ₂ O	118	13.6	[5]
Mesoporous CuO hollow sphere	120	0.14	This work

Table S2. Detection of H₂O₂ in commercial milk samples.

Sample	Added (μ M)	Found (μ M)	Recovery (%)	RSD (%)
Milk	0	/	/	/
	20	21.10	105.5	3.4
	50	49.88	99.8	0.83
	100	102.15	102.2	0.72

Table S3. Comparison of various nanomaterials-based sensors for H₂O₂ detection.

Materials	Linear range (μM)	Detection limit (μM)	Reference
CuO assembled on silicon nanowires	10-13180	1.6	[6]
CuO-g-C ₃ N ₄	2-150	1.2	[7]
Co ₃ O ₄ anchored to multiwalled carbon nanotubes	20-43	2.46	[8]
CuO/PANI hybrid nanofibers	5-9255	0.11	[9]
Graphene wrapped Cu ₂ O nanocubes	300-7800	20.8	[10]
Fe ₃ O ₄ @Cu@Cu ₂ O	4000-50000	2000	[11]
N-G-Fe ₃ O ₄	0-10000	17.1	[12]
Cu ₂ O-rGO	30-12800	21.7	[13]
copper sulfide-decorated Ca-montmorillonite	30-200	24.7	[14]
Cu ₂ (OH) ₃ Cl-CeO ₂	20-50	10	[15]
CuO/Cu	2-19.4	2.0	[16]
V ₂ O ₅ -CeO ₂	20-180	3.0	[17]
CuO nanosheets on copper foil	10-20,000	10	[18]
Mesoporous CuO hollow sphere	10-150	2.4	This work

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