

Supplementary Information

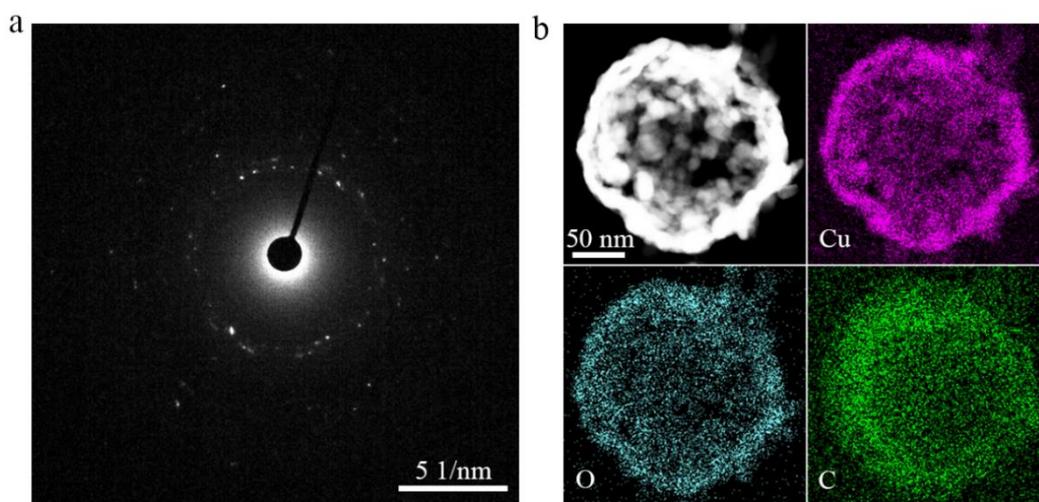
## Synthesis of Mesoporous CuO Hollow Sphere Nanozyme for Paper-based Hydrogen Peroxide Sensor

### Synthesis of mesoporous CuO hollow sphere

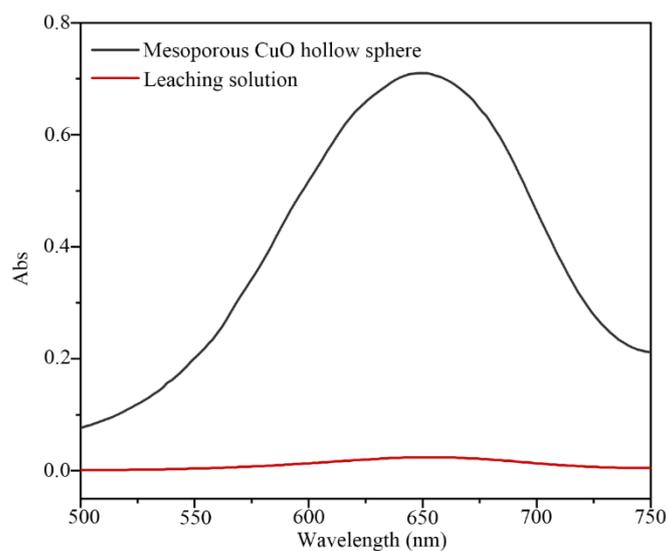
Typically, F127 (0.2 g) was dissolved in the mixture of water (37 mL), ethanol (8 mL) and ammonia solution (0.35 mL, 25 wt%). TA (0.2 g in 8 mL of water) solution was then added to the above solution. Formaldehyde solution (3.8 mL, 3.7 wt%) was added to cross-link the polyphenol. After stirring for 24 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

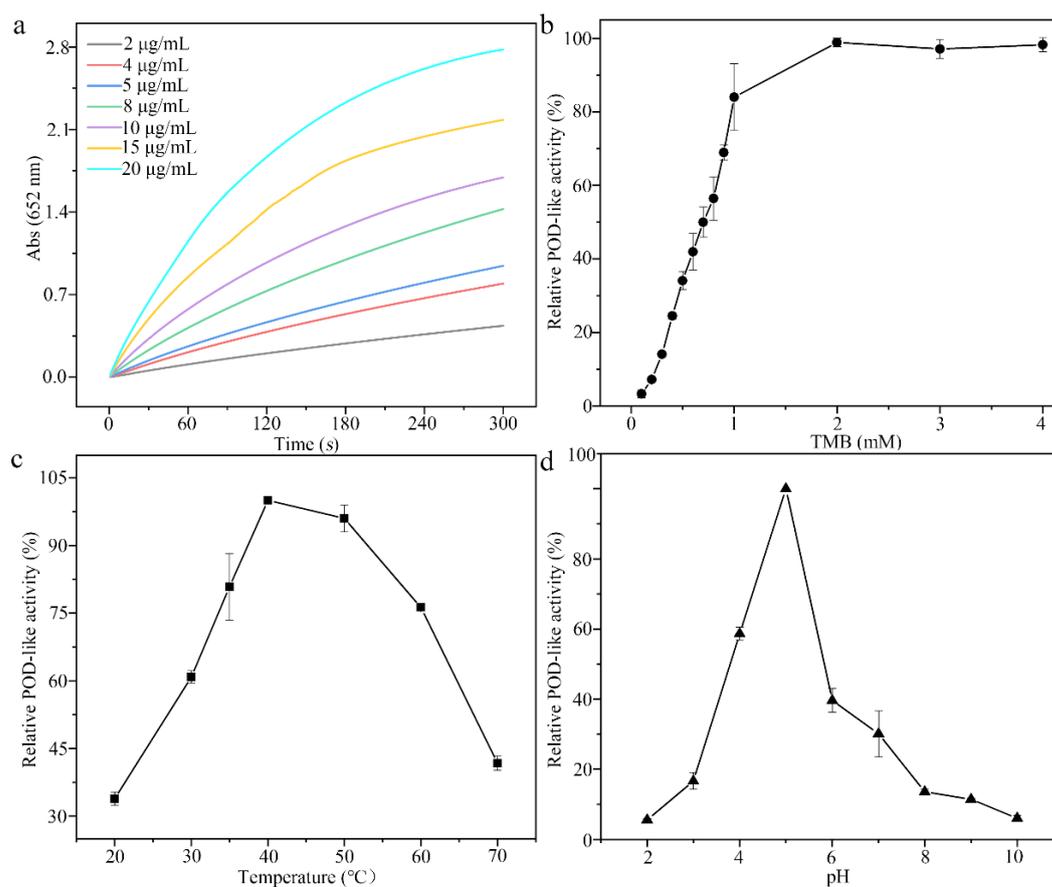
Scanning electron microscopy (SEM) images were obtained on a Gemini SEM500. Transmission electron microscopy (TEM) images and selected area electron diffraction (SAED) patterns were taking using a JEM-F200. Nitrogen adsorption/desorption isotherms were measured with a Micromeritics Tristar 3020. X-ray 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  $\text{Al K}\alpha$  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.



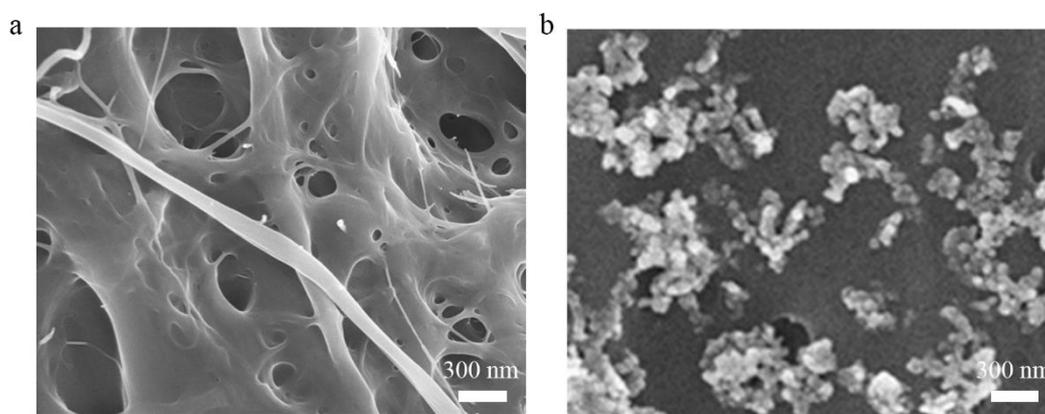
**Figure S2.** The catalytic activity of leaching solution and mesoporous CuO hollow sphere. The leaching solution was prepared by incubation of the Cu-TA-350 nanozyme in the buffer solution with a pH value of 5.0 for 30 min followed by removal of solid products.



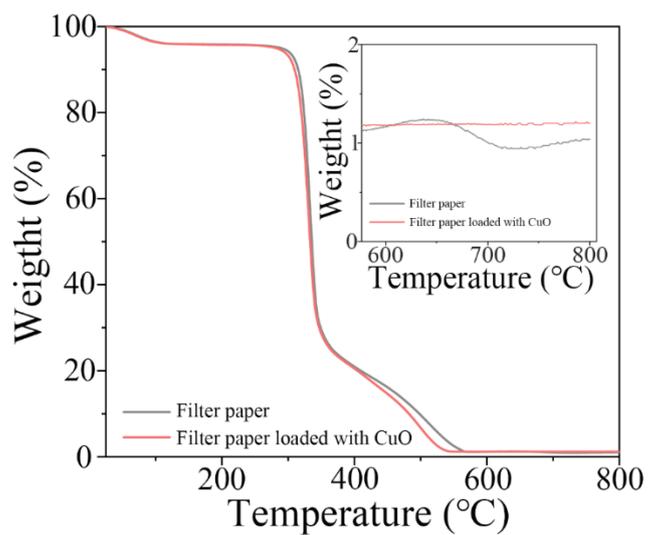
**Figure S3.** (a) Reaction-time curves of TMB colorimetric reactions in the present of different concentrations of Cu-TA-350 solution. (b-d) The relative POD-like activity at different conditions: (b) concentrations of TMB, (c) reaction temperature, (d) pH value in the reaction system.



**Figure S4.** The optical photographs of different concentrations of H<sub>2</sub>O<sub>2</sub> (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 <sup>-1</sup> )	refs
HRP	3.7	87.1	[1]
CuO	400	104.9	[2]
Fe <sub>3</sub> O <sub>4</sub>	154	79.8	[3]
Co <sub>3</sub> O <sub>4</sub>	140	121	[4]
Pure Cu <sub>2</sub> O	118	13.6	[5]
Mesoporous CuO hollow sphere	120	0.14	This work

**Table S2.** Detection of H<sub>2</sub>O<sub>2</sub> in commercial milk samples.

Sample	Added ( $\mu$ M)	Found ( $\mu$ 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 H<sub>2</sub>O<sub>2</sub> detection.

Materials	Liner range ( $\mu\text{M}$ )	Detection limit ( $\mu\text{M}$ )	Reference
CuO assembled on silicon nanowires	10-13180	1.6	[6]
CuO-g-C <sub>3</sub> N <sub>4</sub>	2-150	1.2	[7]
Co <sub>3</sub> O <sub>4</sub> anchored to multiwalled carbon nanotubes	20-43	2.46	[8]
CuO/PANI hybrid nanofibers	5-9255	0.11	[9]
Graphene wrapped Cu <sub>2</sub> O nanocubes	300-7800	20.8	[10]
Fe <sub>3</sub> O <sub>4</sub> @Cu@Cu <sub>2</sub> O	4000-50000	2000	[11]
N-G-Fe <sub>3</sub> O <sub>4</sub>	0-10000	17.1	[12]
Cu <sub>2</sub> O-rGO	30-12800	21.7	[13]
copper sulfide-decorated Ca-montmorillonite	30-200	24.7	[14]
Cu <sub>2</sub> (OH) <sub>3</sub> Cl-CeO <sub>2</sub>	20-50	10	[15]
CuO/Cu	2-19.4	2.0	[16]
V <sub>2</sub> O <sub>5</sub> -CeO <sub>2</sub>	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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