# Supporting Information

## Enzyme-mimetic Catalyst Modified Nanoporous $SiO_2$-Cellulose Hybrid Composites with High Specific Surface Area for Rapid $H_2O_2$ Detection

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## Experimental Section

**Reagents:** Tetraethyl orthosilicate (TEOS), Hexadecyl trimethyl ammonium Bromide (CTAB) and 3,3,5,5,-tetramethylbenzidine (TMB) were purchased from Aldrich. 3-Triethoxysilylpropylamine (APTES), Hydrogen peroxide ($H_2O_2$, 30%), $FeCl_3 \cdot 6H_2O$, and hydrochloric acid (37%) were purchased from sinopharm of China. All the solvents were guaranteed reagents and were used without further purification. The water used in all the related experiments was purified by using a Milli-Q Advantage A10 system with resistivity higher than 18.2 MΩ cm.

**Preparation of silica sols:**

A pre-hydrolyzed solution was prepared by refluxing an ethanolic solution containing TEOS, APES, deionized water, and hydrochloric acid in the molar ratio of 1 TEOS: $2.5\times10^{-3}$APTES:3.18EtOH: $8\times10^{-3}$ HCl: 5 $H_2O$ at 60$^{o}$C for 1 h. A second solution obtained by dissolving CTAB in ethanol was then added to the pre-hydrolyzed solution, together with an additional amount of water and HCl. Typical molar ratios were 1 TEOS: $2.5\times10^{-3}$APTE : 24 EtOH: $8\times10^{-3}$ HCl:5 $H_2O$:0.1 CTAB.

**Preparation of mesoporous-silica coated cellulose microbfibers (NP-Si-Cell):**

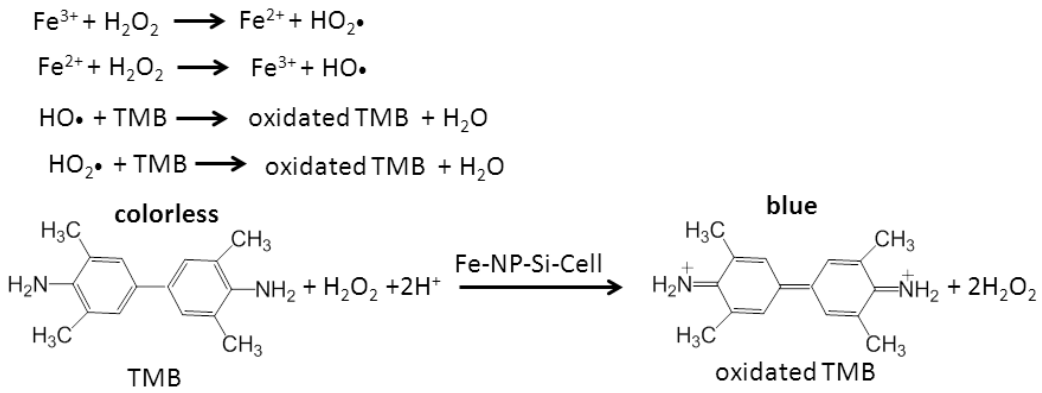
Mesoporous silica coated natural cellulose substance (degreasing cotton or common commercial filter paper, quantitative ashless) was realized by means of a surface sol-gel process. Briefly, a piece of cellulose substance was placed in a suction unit and then the as-prepared silica sol was slowly added into the buchner funnel with fritted disc. The solution was left to stand for 3-10 min to achieve chemical adsorption of the precursors on the cellulose surface. Then the solution was allowed to pass through the cellulose substance within 1 min under vacuum and kept for about 5 min to make sure the solution among the spaces of celluloses has been taken out. The deposition cycle can be repeated to control the thickness of the silica shell. In our experiments, 8 cycles have been done. The silica gel coated cellulose substance was then dried at room temperature for 24 h. At last, the sample was extracted for 3 days by ethanol to get the white NP-Si-Cell.

**Preparation of peroxidase-like catalyst (Fe-NP-Si-Cell):**

To prepare the peroxidase-like catalyst (Fe-NP-Si-Cell), 0.5g of the NP-Si-cell (cotton or pieces of filter papers 3-5 cm×1 cm) was first placed into the flask containing 60 mL dimethylformamide (DMF) and excess of $FeCl_3 \cdot 6H_2O$ (0.4 g). And then the mixture was refluxed for 10 h under the $N_2$. After cooling down to room temperature, the yellow Fe-NP-Si-Cell was washed with 30 mL ethanol for 3 times to make sure the adsorbed $FeCl_3$ was washed out. Finally, the Fe-NP-Si-Cell was dried at room temperature for 24h to obtain the peroxidase-like catalyst. To prepare the peroxidase-like test paper, the Fe-NP-Si-Cell (filter-paper as raw material) was soaked in 50 mL of TMB ethanol solution (0.05 mM) for 10 h, and then the Fe-NP-Si-Cell loaded TMB (Fe-NP-Si-Cell-TMB) was place in oven at 100 $^oC$ for 10 h to get the enzyme-mimetic test paper for $H_2O_2$ detection.

**Characterization**

X-ray diffraction (XRD) patterns were collected on a Bruker D8 Advance diffractometer using Cu K$\alpha$ radiation (wavelength $\lambda$ = 1.5147 Å). Transmission electron microscopy (TEM) images were taken using a field emission H-7600 electron microscope at 120 kV. Scanning electron microscopy (SEM) analysis was conducted on a Hitach S-4800 electronic microscope working at 200 kv. Energy dispersive X-ray (EDX) spectra was collected from an attached energy-dispersive spectrometer fixed on the S-4800 electronic microscope. Nitrogen sorption-desorption isotherm was measured at 77 K on a micromeritics ASAP 2020 m+c sorptometer. Before measurement, the samples were degassed in a vacuum at 120℃ for 12 h. The Brunauer-Emmett-Teller method was utilized to calculate the specific surface areas using adsorption data in a relative pressure range from 0.05 to 0.4. UV-Vis spectra were recorded on a HITACHI U-4000 Spectrophotometer. TGA was carried out on a Rubotherm-DytherM system (heating rate: 10 $^oC$/min, $O_2$ atmosphere).




Scheme S1. Schematic illustration of peroxidase-like activity for the Fe-NP-Si-Cell.

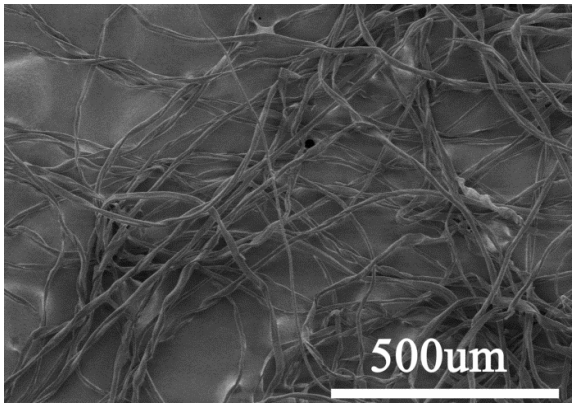



Figure S1 Scan electron micrographs (SEM) image of cotton.

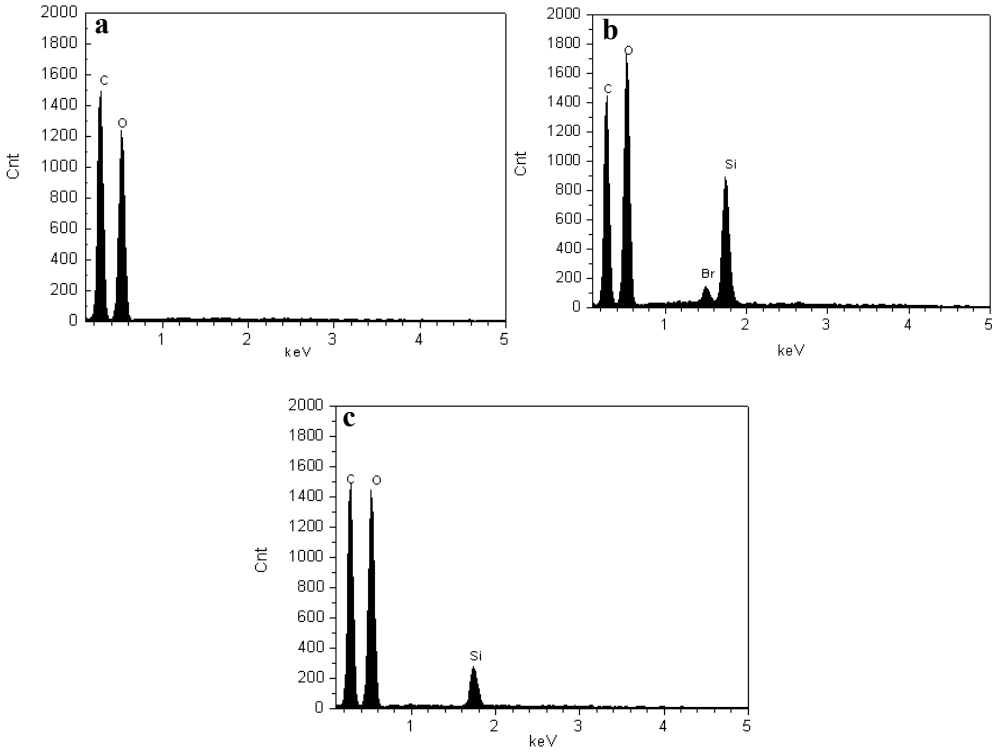



Figure S2 EDX spectra for (a) cotton, (b) nanoporous silica coated (NP-Si-Cell) cotton without template removing, (c) NP-Si-Cell with template removing.

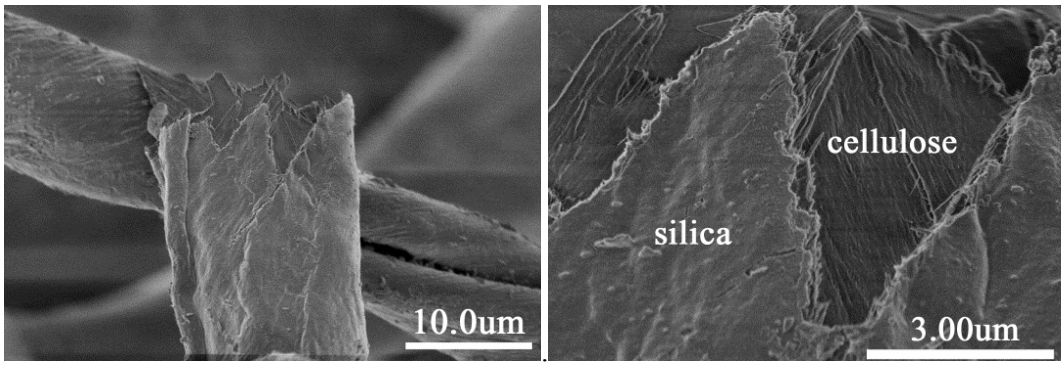



Figure S3 Cross-section of NP-Si-Cell.

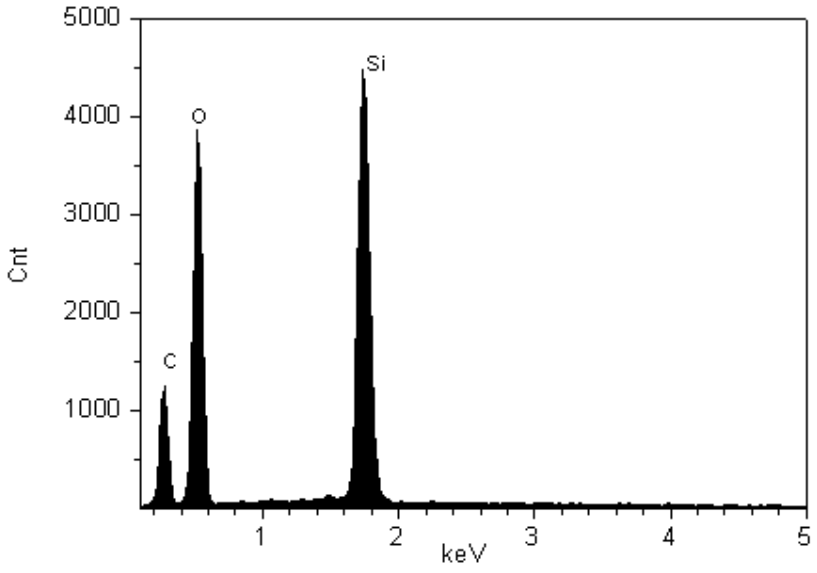



Figure S4 EDX spectra of calcined NP-Si-Cell.

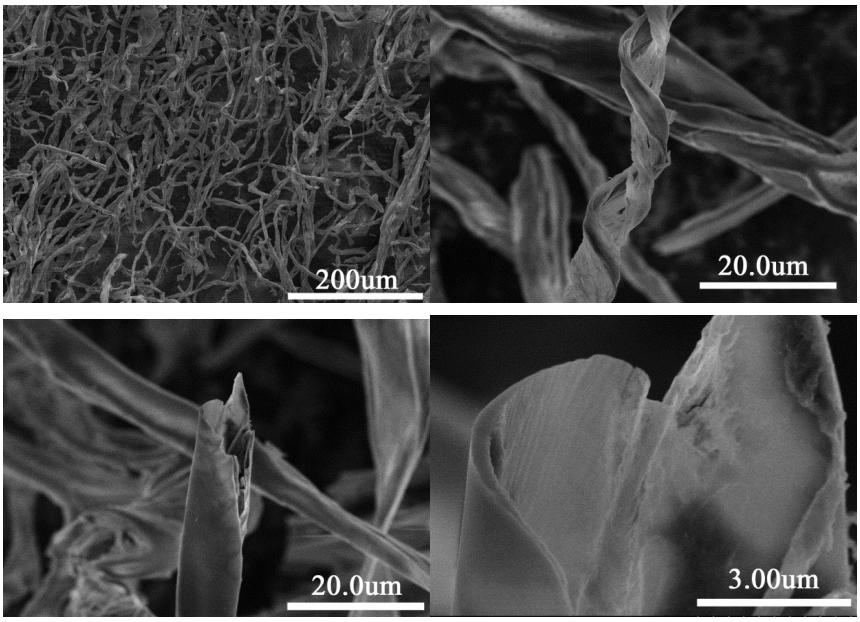



Figure S5 SEM images of calcined NP-Si-Cell.

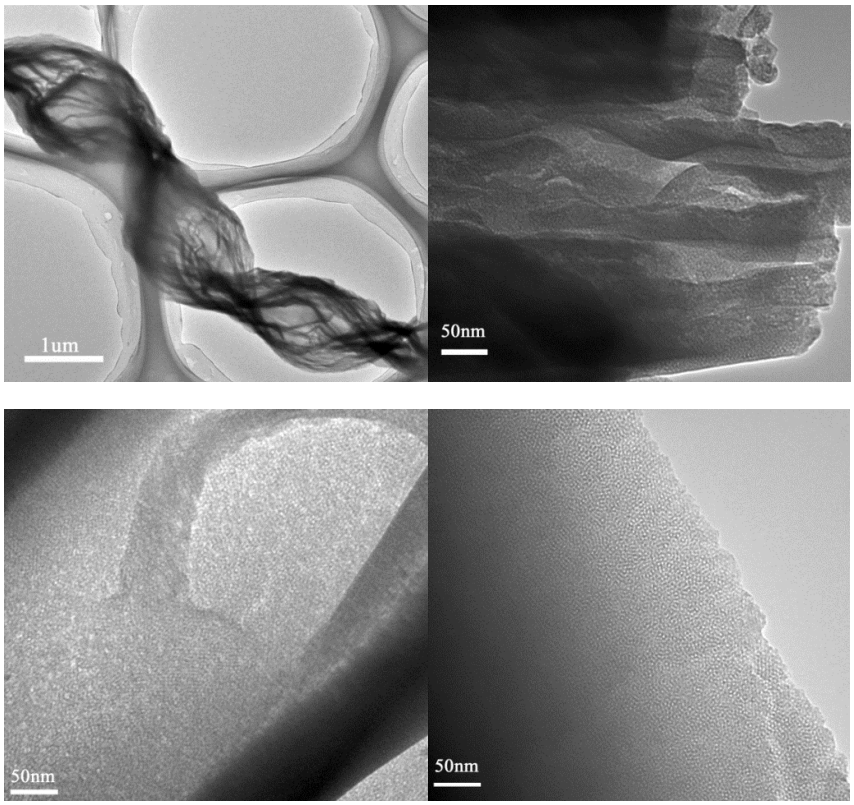



Figure S6 TEM images of calcined NP-Si-Cell.

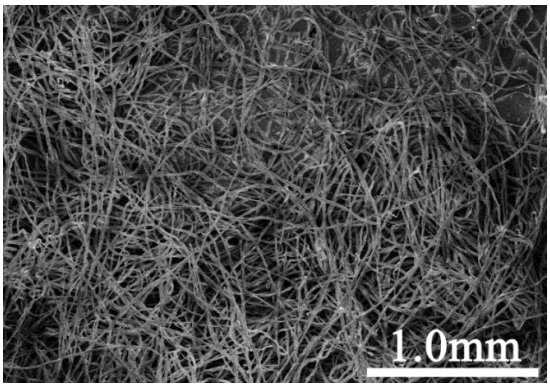



Figure S7 SEM image of Fe-NP-Si-Cell.

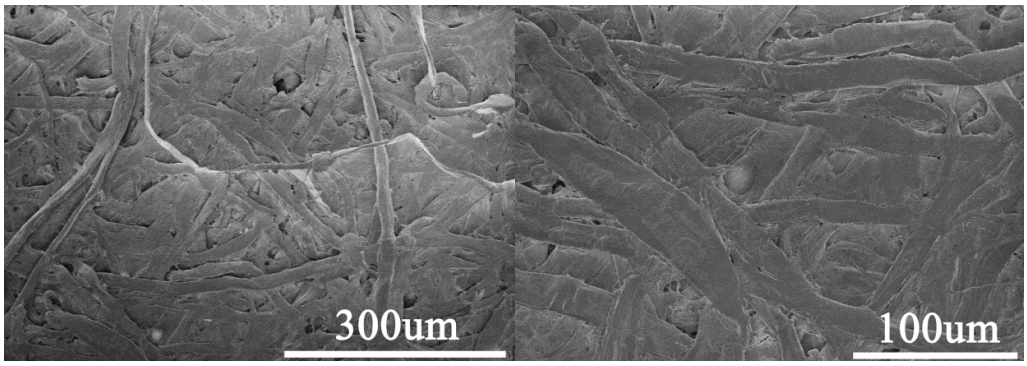



Figure S8 SEM images of filter paper.

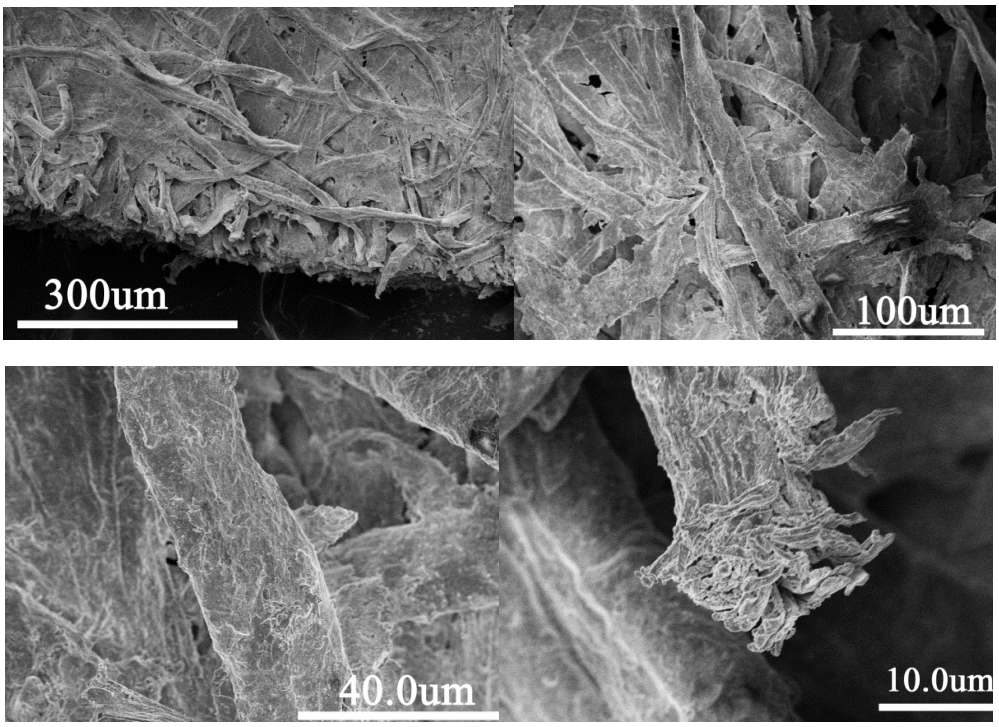



Figure S9 SEM images of nanoporous silica coated cellulose of filter paper.

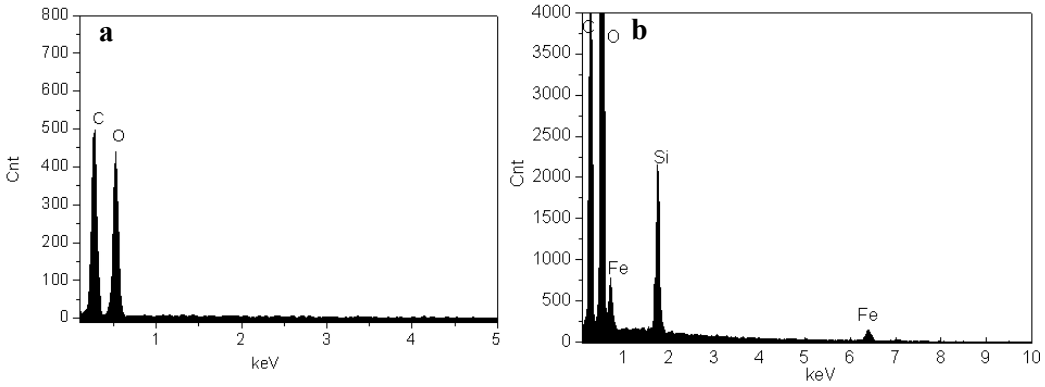



Figure S10 EDX of (a) filter paper and (b) Fe-NP-Si-Cell (filter paper as raw material).

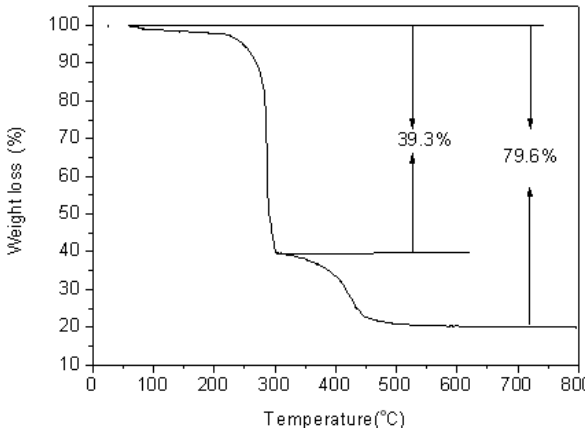



Figure S11 TG curve of NP-Si-Cell.

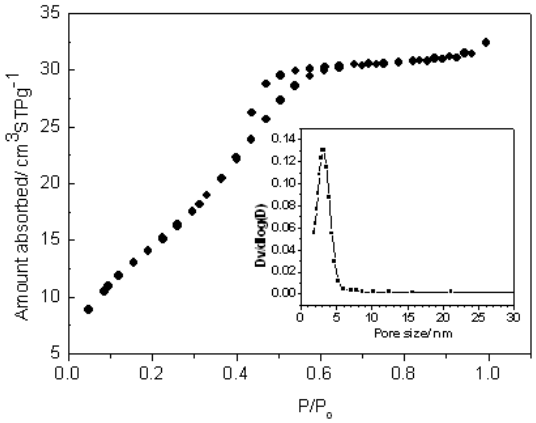



Figure S12 $N_2$ adsorption and desorption isotherms of NP-Si-Cell, inset is the pore sized distribution.

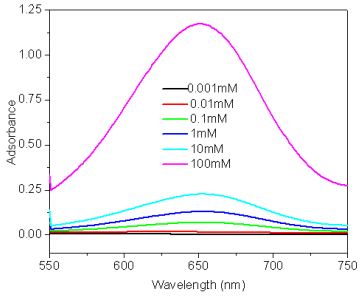



Figure S13 UV-vis spectra of the solution with different concentration of $H_2O_2$ catalyzed by peroxidase-like catalyst (Fe-NP-Si-Cell).

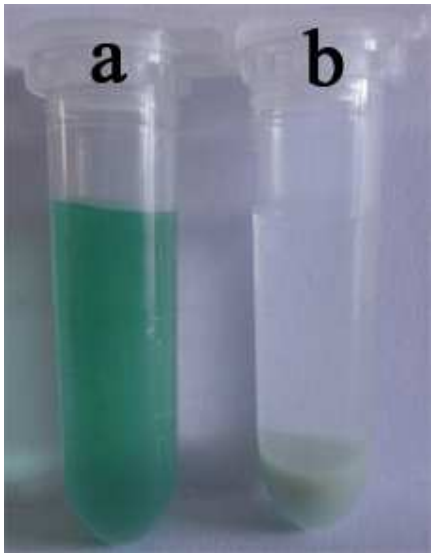



Figure S14 The photographs of (a) the solution containing oxidated TMB (b) the oxidated TMB adsorbed on MCM-41 in the solution.

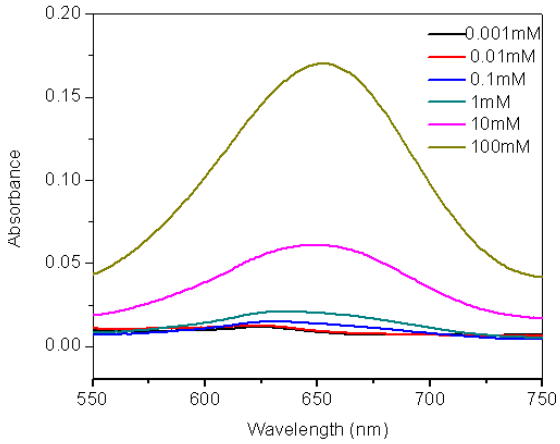



Figure S15 UV-vis spectra of the solution with different concentration of $H_2O_2$ catalyzed by peroxidase.

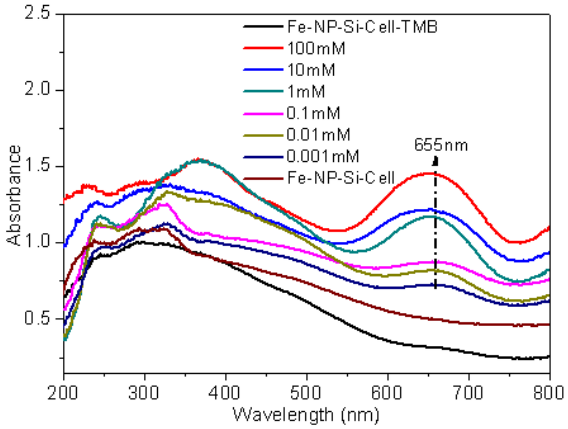



Figure S16 UV-vis spectra of the test papers with and without different concentration of $H_2O_2$.

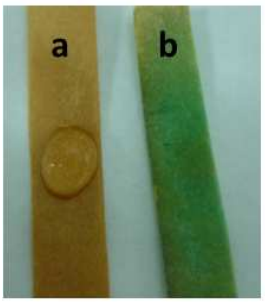



Figure S17 Peroxidase-like test paper coated with a) solid $SiO_2$ and b) mesoporous $SiO_2$ by sol-gel method in the present of 0.01mM $H_2O_2$ aqueous solution.

Solid $SiO_2$ was coated by TEOS solution containing 20 mL ethanol, 0.5 mL TEOS, 0.01 mL APTES, 4 mL water and 0.05 mL wt 37% HCl.

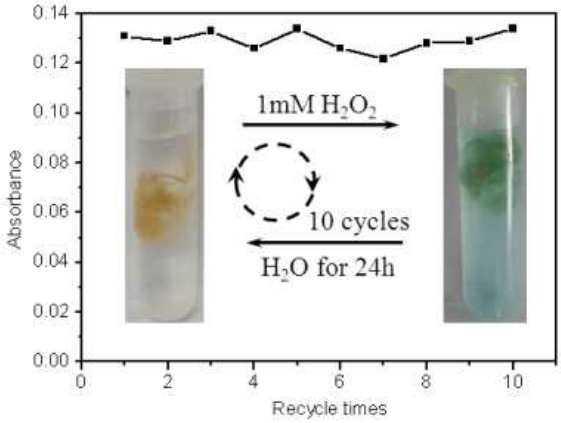



Figure S18 The reversible detection of $H_2O_2$ using the Fe-NP-Si-Cell (cotton based). Reaction conditions: (4 mL $H_2O_2$ including 200μL 5mM TMB, 40 $^oC$, pH=5.5-6.0, 10 mg catalyst, 10 min).