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To cite this article: Zunfu Hu *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **252** 022093

IOP Conf. Series: Earth and Environmental Science **252** (2019) 022093 doi:10.1088/1755-1315/252/2/022093

In situ growth of PtMn nanoparticles on Layered Double Hydroxide for colorimetric determination of hydrogen peroxide

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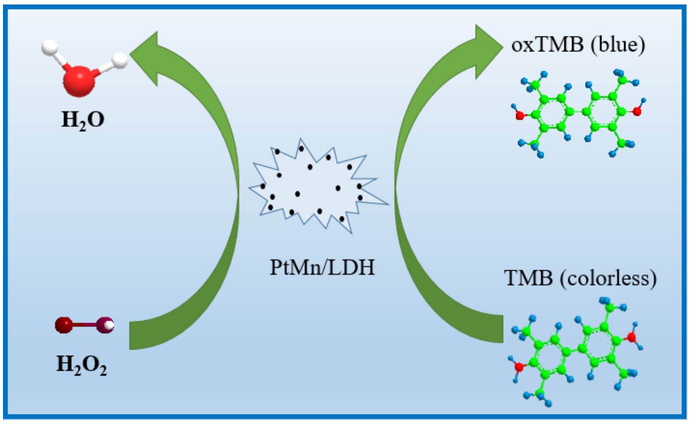
Abstract. In this report, Platinum manganese nanoparticles (PtMn NPs) were attached onto Layered Double Hydroxide (LDH) via a facile in-situ growth strategy. Based on the prepared nanoparticles, a novel colorimetric sensor for fast and sensitive determination of H_2O_2 was established. The established colorimetric sensing platform exhibited perfect peroxidase-like activities confirmed by oxidating 4, 4'-Bi-2, 6-xylidine (TMB) with H_2O_2. The sensing platform was pH and temperature-dependent.

1. Introduction

Hydrogen peroxide (H_2O_2) plays an indispensable important role in series of industries, such as mining, national defense security, environmental protection, medicine and health, catering industries and so on [1-3]. Hence, it got a lot of attention about how to sensitive, rapid detect H_2O_2. As so far, numerous of analytical methods were developed, such as colorimetric [4], gas chromatographic [5], electrochemical method [6], liquid chromatographic and fluorescent spectrometry [7-10]. Nevertheless, it is still of great value to design simple, efficient and sensitive colorimetric strategy for the determination of H_2O_2 [11].

Due to its great specific surface area, easy modification and controllable size, two-dimensional nano-materials have attracted a lot of attentions in the fields of analytical fields [12-14]. Herein, we report an in suit growth of PtMn nanoparticles on Layered Double Hydroxide for colorimetric determination of hydrogen peroxide. Hydrothermal synthesis method was utilized to obtain the Layered Double



Scheme 1. The catalytic mechanism of PtMn/LDH for colorimetric determination of H_2O_2**.**

Hydroxide (LDH) and PtMn/LDH [15]. The obtained nano-composites were utilized as peroxidase-like enzyme to colorimetric determination of H_2O_2, the corresponding catalytic mechanism was shown in Scheme 1.

2. Experimental

2.1. Materials
4, 4'-Bi-2,6-xylidine (TMB), hydrogen peroxide (H_2O_2), Iron (III) acetylacetonate (Fe $(acac)_3$) and Acetylacetone Platinum (II) (Pt $(acac)_2$) were got from Aladdin.

2.2. Colorimetric Detection of H_2O_2
In the typical operation, 200 μL TMB (1mM), 200 μL PtMn/LDH (30 μg/mL) and 200 μL H_2O_2 (0.2 M) were sequentially added into 1400 μL Citric acid buffer (pH 4.2). When the reaction solutions were incubated for 3 min, the absorption of the solution was performed on the UV-vis spectrometer.

3. Results and Discussion

3.1. Preparation of PtMn/LDH NPs
Layered Double Hydroxide (LDH) and Platinum manganese nanoparticles (PtMn NPs) attached Layered Double Hydroxide nano-composites (PtMn/LDH NCs) were obtained by hydrothermal synthesis method. As shown in Figure 1(A) and (C), the obtained LDH and PtMn/LDH presented a remarkable Maple leaf shape, the corresponding high resolution TEM pictures were also shown in Figure 1 (B) and (D).

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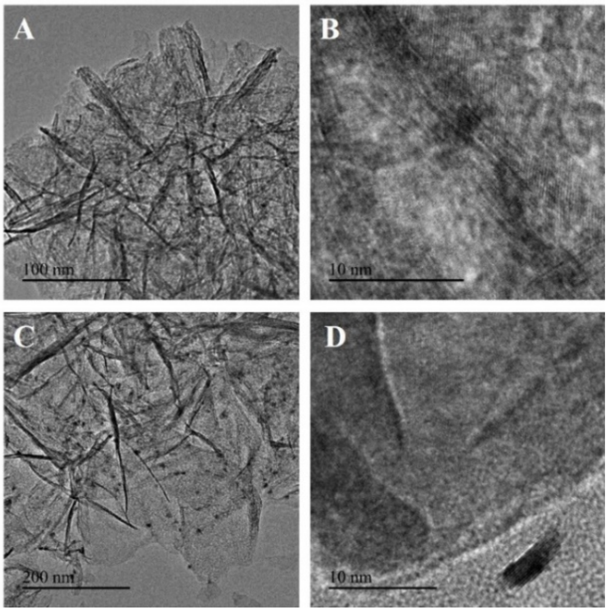
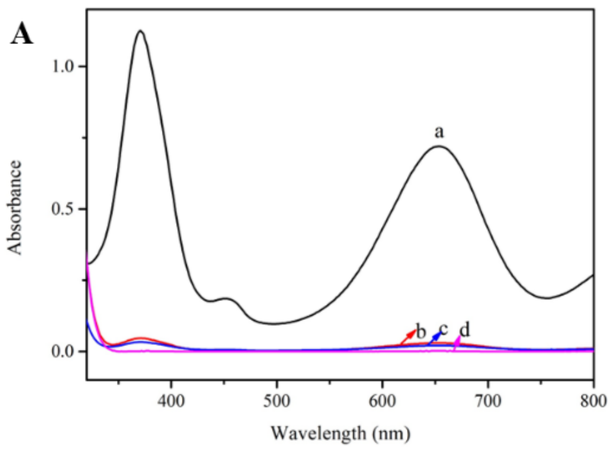


Figure 1. (A) TEM picture of the obtained Layered Double Hydroxide; (B) HRTEM of LDH; (C) TEM of the in-situ growth PtMn/LDH; (D) HRTEM of the PtMn/LDH.

Four experimental groups were designed to investigate the catalytic properties of the obtained PtMn/LDH, while TMB was selected as the chromogenic substrate. The strongest absorbance was got by system a (TMB+PtMn/LDH+H_2O_2, line a), which indicated that, with H_2O_2, PtMn/LDH could effectively catalytize the deccomposition of H_2O_2. In the absence of H₂O2, the color of systems b (TMB + PtMn/LDH) and d kept colorless, indicating TMB kept unoxidized, shown in Figure 2(A). These results clearly demonstrate that PtMn/LDH possess peroxidase-like activity.



B	a	b	c	d
PBS	√	√	√	√
PtMn/LDH	√	√		
H_2O_2	√		√	
TMB	√	√	√	√

Figure 2. (A) The UV-vis spectrum the four systems; (B) The constitue of the four colorimetric systems.

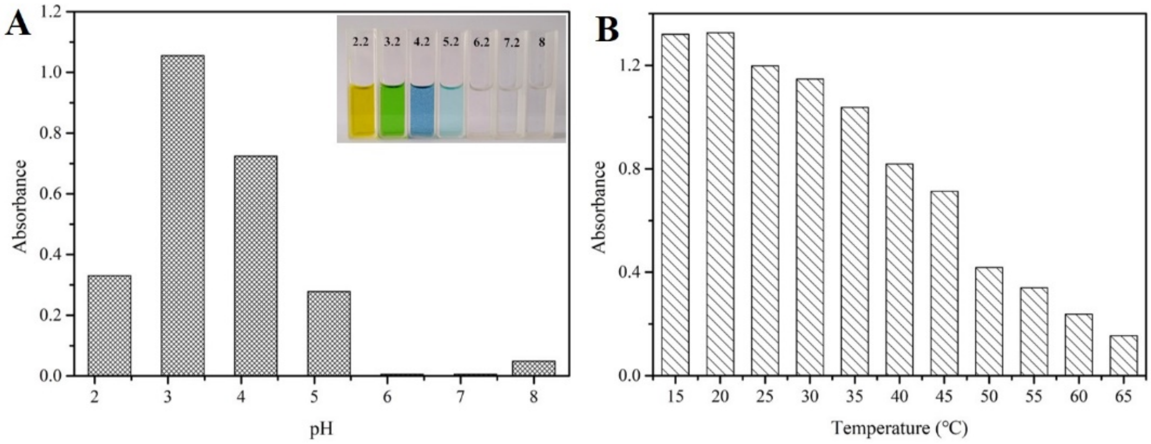


Figure 3. The influence of pH (A) and Temperature (B) of the solution on the colorimetric systems.

As illustrated in Figure 3, as pH of the reaction solution altered from 2.2 to 8 the absorbance at 652 nm reached the maximum at pH 3.2. It was found that the optimal pH of the catalytic reaction was got to be 3.2. In the same way, the influence of the temperature on the catalytic reactions was studied as the temperature alter from 15 to 65℃. It was found that as the temperature increased, the absorbance of the reaction solution decreased slowly, indicating the optimal temperature was 20℃.

4. Conclusion

In summary, PtMn/LDH were synthesized in a facile way and applied as peroxidase-like enzyme to establish a sensitive and fast sensing platform for colorimetric determination of H_2O_2. Verified by series of experiments, PtMn/LDH exhibit excellent peroxidase-like activity.

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