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A New Property of Conjugated Polymer PFP: Catalytic Degradation of Methylene Blue Aqueous Solution

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Abstract: A new property of conjugated polymer poly(furancarbinol-*co*-phenol)(PFP) was studied. The target copolymer was used as a catalyst after proper heating treatment. And dye methylene blue (MB) could be fully degraded and largely mineralized on PFP, under natural light or even in dark, in a few minutes. Furthermore, the catalytic activity could be preserved after several runs and the catalyst was readily separated. The effect of calcination temperature was also observed.

Keywords: PFP, catalytic property, MB, degradation, mineralization.

Since titanium dioxide has been widely used as catalyst in the treatment of polluted water, a lot of relevant problems have been found synchronously, such as low conversion efficiency of solar energy, poor reuse and difficult post-treatment, *etc*, which limited its technological applications. Therefore, many researches aimed to develop new type of catalyst[1~5], particularly through combining it with some conjugated polymers[6,7]. However, the stability of these catalysts has not been reported. Also the catalytic property of some conjugated polymers alone has not been investigated.

On the basis of these thinking, our group has designed and prepared a new type of conjugated polymer poly(furancarbinol-*co*-phenol)(PFP) catalyst through a simple procedure, and its catalytic property on the decolorization of dye MB was investigated with FT-IR, UV-Vis and COD, respectively. The results showed that PFP could catalyze the degradation and mineralization of MB, under natural light or even in dark, within a few minutes.

Furthermore, it was reusable and was easily separated. Therefore, it could be expected that PFP would be an alternative catalyst in water pollution treatment.

Experimental

The PFP was prepared as follows: 10.0 g of phenol was rapidly dissolved in 10.0 mL of furancarbinol with vigorously stirring, and then the mixture was copolymerized at room temperature with H_2SO_4 catalyst for 0.5 h to form the PFP. Finally the copolymer was activated by appropriate heating treatment, and ground into powders (the average size

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was about 200 nm).

25 mg PFP powders was added into 25.0 mL MB solution (10 mg/L) and the system was stirred under natural light or in dark. The absorbency of sample solution was measured with a 721 spectrophotometer.

Results and Discussion

Under natural light or even in dark, dye MB could be fully decolorized on PFP (activated at about 600℃ for 15 minutes) in 5 minutes. The UV absorption peaks corresponding to the dye molecules disappeared, and no absorption bands of aromatic moieties and for other intermediates (**Figure 1**). This implied that the dye might be fully degraded or strongly adsorbed on the polymer PFP.

The infrared spectra of the PFP, before and after treatment with the dye coincided with each other (**Figure 2**). It indicated that the polymer did play a role of catalyst.

The COD data of MB and decolorized solutions, on the polymer and commercial TiO_2 (Beijing Chemical Plant), were all determined according to ref[8] (**Table 1**). The results showed that on the polymer, the mineralizing efficiency could reach 75.35% under natural light or even in dark in 5 minutes while on TiO_2, under UV light radiation after 3 h, only 57.40%. It indicated that the dye molecules were largely mineralized on the PFP. The catalytic property of PFP was remarkably superior to that of TiO_2.

Figure 1 UV absorption spectra of MB solution before (a) and after (b) treatment with PFP

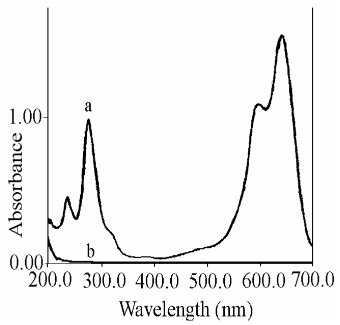


Figure 2 IR spectra of PFP before (a) and after (b) treatment with the dye

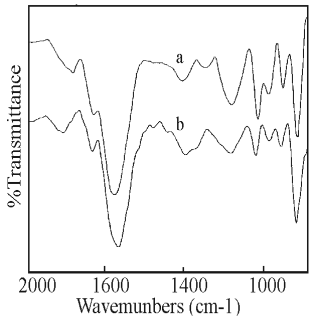


Table 1 COD data of MB solution before and after being decolorizing on different catalysts

Comparison	COD (mg/L)			Confidence interval	Mineralization rate of COD (%)
MB solution	44.9	42.8	40.7	36.9±8.5	0
	40.7	28.3	24.2		
on PFP	19.7	17.8	8.2	9.1±7.9	75.35%
	5.6	2.5	0.9		
on TiO_2	20.7	19.9	18.5	15.7±5.6	57.40%
	18.1	9.3	7.9		

Then the effect of temperature on the stability of the polymer catalyst was also examined. The results were shown in **Figure 3**. The treatment time was 15 minutes. The optimum temperature was about 600℃. The reason might be involved in their different conjugation structures (**Figure 4).**

Moreover, the separation of the polymer catalyst PFP from the suspension was easier than TiO_2, although their sizes were similar.

In conclusion, a new property of conjugated polymer PFP was obtained. It exhibited high catalytic activity and stability for the degradation and mineralization of dye MB under natural light or even in dark, in a short time. Furthermore, it was easily separated compared with other inorganic catalysts. Therefore, it could be a promising material for large-scale applications.

Figure 3 Relationship between catalytic stability and treatment temperature

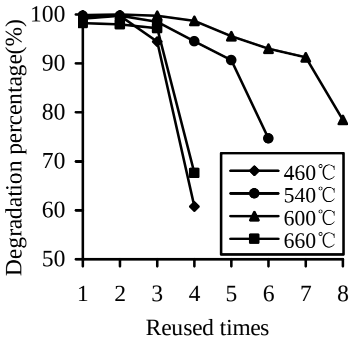
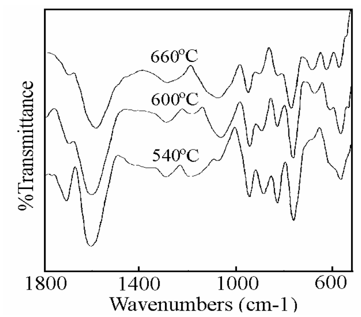


Figure 4 Infrared spectra of the polymers treated at different temperatures



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