

Pomelo Peel Biochar Design and the Adsorption and Photo Catalytic Properties

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Abstract. In our work, pomelo peel was used as raw material and carbonized by hydrothermal treatment and calcination in air, respectively, to obtain the corresponding pomelo peel biochar. The effects of two different treatment conditions on the adsorption and photo catalysis performance of the product were investigated. The experimental results show that the hydrothermal pomelo peel biochar has a better ability to degrade Rhoda mine B under visible light than the biochar obtained by calcining.

Introduction

With the rapid development of industry, the variety and quantity of dyes are increasing and the threat to the ecological environment is becoming more and more serious. Dyes are widely used in food, medicine, cosmetics, printed matter, printing and dyeing industries; its wastewater has become one of the recognized industrial wastes that are difficult to handle at home and abroad. There are many methods for the treatment of dye waste water, such as precipitation, flocculation, adsorption and photo catalysis, etc. Among them, adsorption has attracted wide attention as an efficient and inexpensive method [1]. Photo catalysis is an efficient and green technology that directly converts solar energy into chemical energy for waste water treatment [2-4]. Since natural biomass materials have the advantages of being biodegradable, reusable, biocompatible, non-toxic and harmless, researchers have tried to replace traditional adsorbent materials with inexpensive natural biomass adsorbent materials [5].

Therefore, we like to report the combination of adsorption and photo catalytic degradation technology to prepare a new type of biomass material that has both adsorption capacity and photo catalytic degradation of organic dye pollutants.

Materials and Methods

Materials and Instruments

Pomelo peel was dried naturally before use. Rhoda mine B (RhB, AR, Damao chemical reagent factory in Tianjin). Powder X-ray Diffraction Apparatus (Mini Flex600, Japan Science Company), scanning electron microscope (Phenom Pro X, Fina Corporation), specific surface area and pore size analyzer (JW-BK122W), UV-Vis spectrophotometer (TU-1950, Cape Analysis).

Pomelo Peel Treatment Methods

Take 2 g pomelo peel for hydrothermal treatment, put pomelo peel into the reactor with 50 ml of clean water and put it into a constant-temperature electric blast drying box, and react at 200 °C for 72 hours. After the reaction, close the drying oven, naturally cool to room temperature, filter, and dried at 100 °C and yielded about 0.6 g product (namely ppC-1 shortened by pomelo peel carbon).

Another 3 g pomelo peel for calcination, put pomelo peel into a pot, and calcined in an air

atmosphere muffle furnace at 300°C for 2 hours and obtained ca.1 g product (namely ppC-2).

Characterization Techniques

The products were subjected to scanning electron microscopy and energy dispersive spectral analysis, specific surface area measurements, powder X-ray diffraction characterization, and UV-visible absorption spectroscopy measurements.

Adsorption and Photo Catalysis Test

Preparation of Target Degradation Product

Weigh 0.020 g of powder of RhB, dissolve it and pour it into a 1000 ml volumetric flask until it is engraved. Prepare 20 mg/L of RhB solution for use.

Test Methods

Take 0.1 g ppC-1 or ppC-2, respectively, in 100 ml RhB solution with a concentration of 20 mg/L, place the magnetite, and test the adsorption performance in a dark environment (dark reaction) with stirring for 0.5 h. Then turn on the light source system, the photo catalytic performance was tested (light reaction), the magnetic stirrer kept stirring constantly during light reaction, and the reaction temperature was kept at room temperature (~25 °C) by cooling water circulation, the xenon light source current was 16 A, the light source was visible light, and its wavelength range was 350-780 nm. Each 0.25 h during the reaction, a small amount of solution was taken from the degrading tank, centrifuged, and the supernatant was taken and measured for UV absorption spectra.

Results & Discussion

Scanning Electron Microscope and Energy Spectrum Analysis

Figure 1 shows the scanning electron microscopy (SEM) (a) and energy dispersive spectrometer analysis (EDS) (b) of ppC-1. It can be seen from the figure that the surface of ppC-1 is rough with voids. The EDS analysis found that the K, O, B, and C elements exist at the point of extraction and the elements were uniformly distributed at each point.

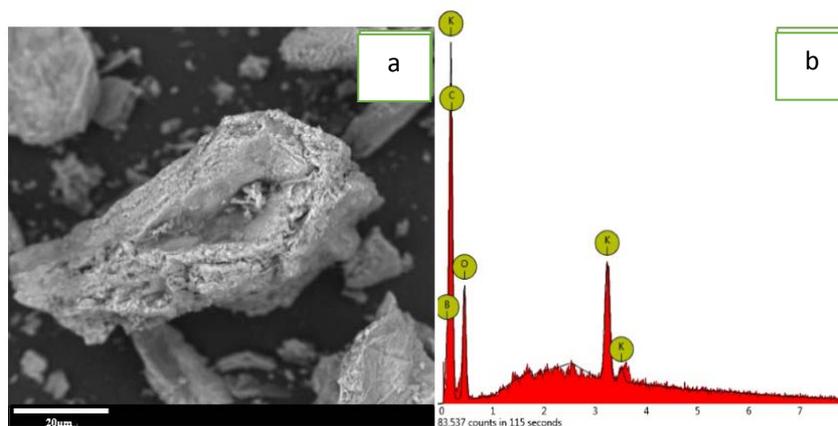


Fig. 1 (a) SEM image of hydrothermal biochar, **(b)** EDS spectrum of hydrothermal biochar

Figure 2 shows the SEM image (a) and EDS data (b) of ppC-2. It can be seen from the figure that the calcined product does not have a significant pore structure, from which speculated that the photo catalytic effect may not be very satisfactory. EDS analysis revealed the presence of O, C, K, Ca, B and other elements at the point of extraction. The elements are evenly distributed at each extraction point, and it is presumed that the calcined material exists mainly as an oxide.

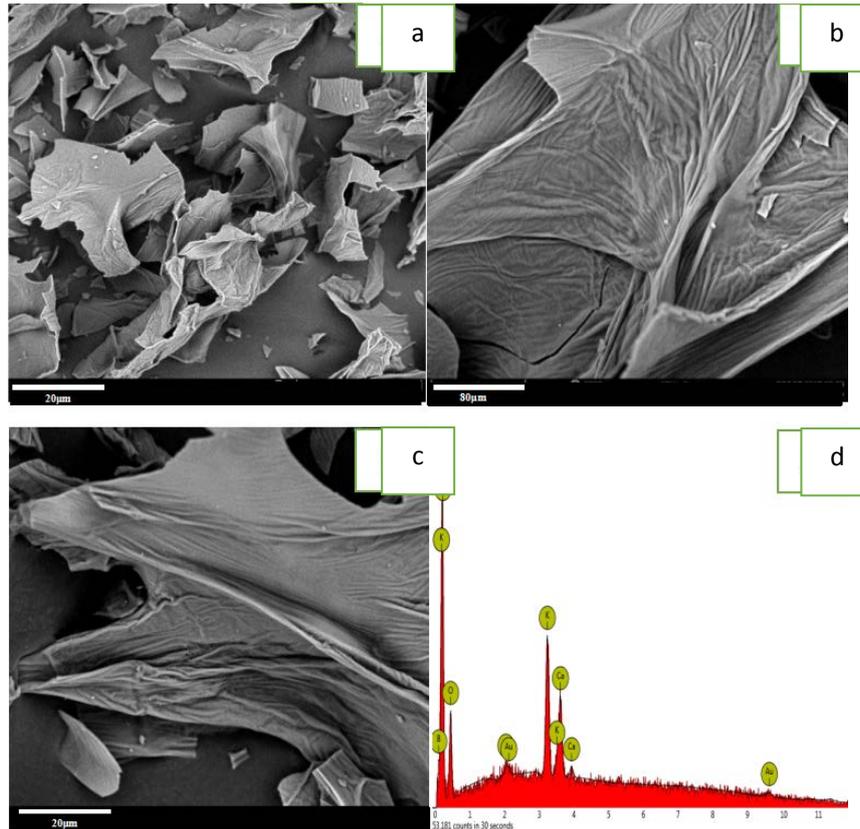


Fig. 2 (a-c) SEM images of calcined biochar in different magnification, (d) EDS spectrum of calcined biochar

Specific Surface Area Analysis

The specific surface area is one of the important factors affecting the photo catalytic performance. Although the specific surface area of the products are small as shown in Table 1, the specific surface area of the material is increased by the hydrothermal treatment, which is caused by rough surface with pores (Fig 1a).

Table 1 The specific surface areas of ppC-1 and ppC-2

product	hydrothermal biochar ppC-1	calcined biochar ppC-2
specific surface areas(m^2/g)	11.94	1.73

Powder X-Ray Diffraction Analysis

Figure 3 shows the powder X-ray diffraction patterns of ppC-1 and ppC-2. Compared with the standard map, it was found that the product contained O, C, B, Ca and other elements, consistent with the analysis results of EDS.

From the powder XRD patterns, it can be seen that there are no diffraction peaks in the products and there are a broad peak near 20 degrees. It can be concluded that the biochar obtained from pomelo peel under hydrothermal and calcining conditions are both amorphous carbon material [6-9].

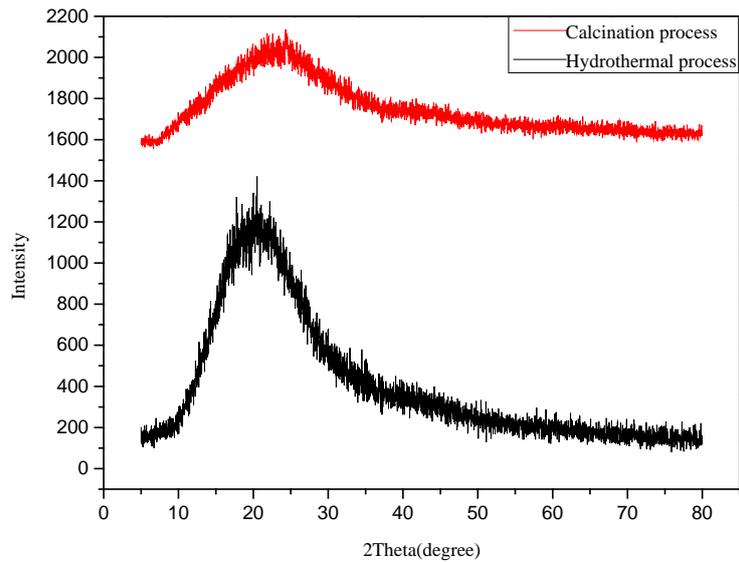


Fig. 3 Powder X-ray diffraction pattern of hydrothermal and calcined biochar

UV-visible Absorption Spectroscopy Analysis

Figure 4 shows UV-visible diffuse reflectance of direct hydrothermal pomelo peel and direct calcined pomelo peel [10]. It can be seen from the figure that the sample absorbs light in the ultraviolet, visible and near-infrared regions, among them; the UV region is the strongest. The calcined products absorb light at all wavelengths and have relatively stable light absorption. In contrast, light absorption in the visible light region is slightly stronger. By comparison, it can be found that the hydrothermal product has stronger light absorption ability and theoretically has a higher utilization rate of sunlight.

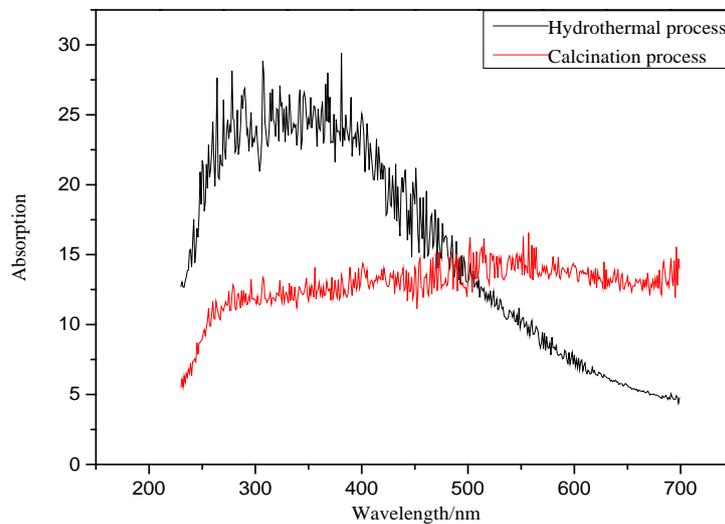


Fig. 4 UV-visible diffuse reflectance of hydrothermal and calcined biochar

Adsorption and Photo Catalytic Analysis

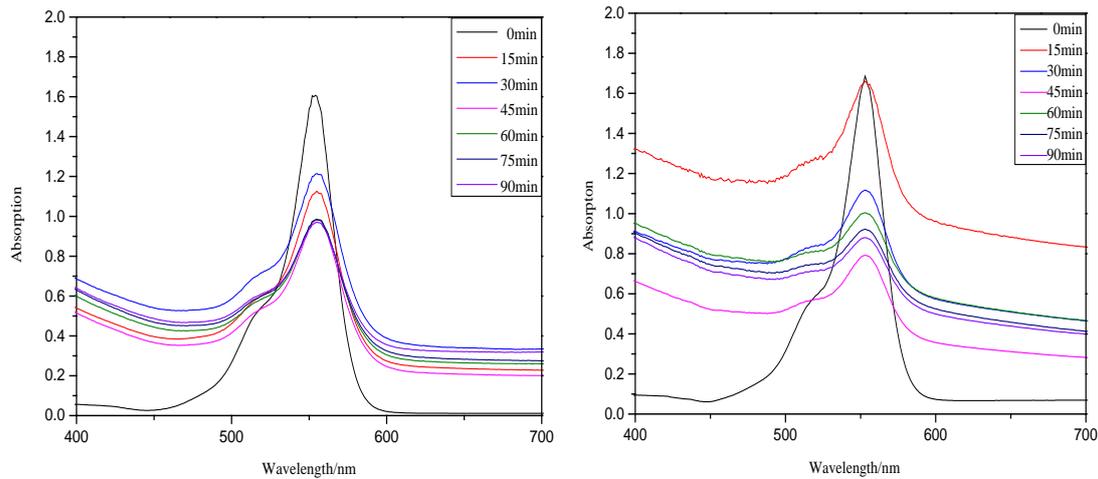


Fig. 5 Degradation of RhB in the presence of hydrothermal and calcined biochar

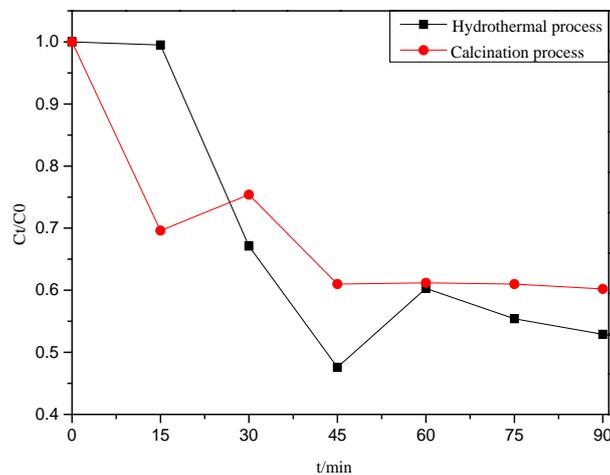


Fig. 6 Comparison of visible light degradation of RhB of two products

It can be seen from figure 5 that both catalysts are effective for the adsorption of RhB under the current experimental conditions. However, from the whole dark reaction to the light reaction process, it can be seen that hydrothermal pomelo peel has better degradability (figure 6). After the 1.5 hour the reaction is over, the degradation rate reached 50.1% and 39.8%, respectively. This may be due to the fact that the surface of ppC-1 obtained by the hydrothermal treatment contains oxygen-containing functional groups and has good chemical reactivity, and through the temperature control, the pomelo peel can lose surface water, bind water and impurities from the pores. Therefore, in the photo catalytic process, RhB can be better degraded to improve the utilization of light energy.

Conclusions

In summary, this work demonstrated that the pomelo peel biochar obtained by direct hydrothermal and calcination, respectively, is useful for the adsorption and photo catalysis of RhB, but hydrothermal biochar is even better. The main reason is that the surface of the product has no pores, the external surface area is small, and the adsorption sites are small, which is not conducive to the adsorption of dyes. Therefore, pomelo can be modified to increase pores to produce biomass materials with high adsorbed and photo catalytic performance.

Acknowledgments

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