Application of WP in RSP/CC Composite

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Abstract. Waste paper was incorporated into the preparation of composite of rice straw powder (RSP) and carobxymethylcelluose (CC) in order to solve the problems of difficult mold release, easy break and low strength during the course of preparing RSP/CC composite. A series of whole composite samples were obtained and the effects of ratio of raw materials and hot-pressing time on the performance of composites were studied. Results showed that the tensile strength of composites increased with the increase of CC content when composite were prepared by hot-pressing at 130℃ for 10 min. The tensile strength arrived at 4.2 MPa when CC mass content was 44%. Strength at tensile break also increased with the increase of CC content as tensile strength. The maximum arrived at 4.1 MPa. Tensile stretch increases with increasing the CC amount. When mass content of CC was changed from 17% to 64%, the tensile stretch changed from 8.7% to 10.8%. Otherwise tensile strength increased with the increase of hot-pressing time.

Introduction

Development of environmentally friendly materials is an important investigation content in materials science field because resource deficiency and environmental pollution are hindering the development of human society and economics. Plant straw is good raw materials to prepare environmentally friendly composite. Plant straw includes many kinds and currently the most often used plant straw is crop straw [1-5]. Liang et al studied the preparation and performance of novel lignocellulosic hybrid particleboard composites with low cost and high performance using the mixture of rice straws and coir fibers [6]. The coir fibers content had a significant negative linear effect on the bending properties and thickness swelling, but a significant positive linear effect on the internal bonding strength due to the lower wax and holocellulose content of coir fiber.

Hot-pressing is an appropriate method of preparing straw based composites and is characterized by high production efficiency, simple technological process and low energy consumption. Our research team carried out wide preliminary exploration in the preparation of crop straw based composite by using hot-pressing method. When RSP and CC were used as raw materials to prepare composite, it was found to be difficult to succeed. Causes contained two aspects. One was that the composite had very low strength and it was difficult to obtain complete composite sample. The other was difficult mold release. In order to solve these two problems, the application of WP in RSP/CC composite was studied here. WP is from renewable resource. If all the raw materials of composite come from renewable resources, the composite has completely environmentally friendly property without a doubt.

Materials and Methods

Materials. WP was obtained from waste general exercise book. RS was obtained from Jiujiang suburbs farmland and was dried in the sun before use. The preparation course of RSP including three procedures: chopping RS into about 1 cm segments, shearing the segments into the mixture of powder and slice and then removing slice by seiving. CC was purchased from Hongda Cellulose company (Heibei, China) and was used as received. Water was obtained from urban water-supplying system.

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Dimethicone oil was purchased from Xilong chemical company (Shantou, China) and was used as received.

Preparation of RSP/CC/WP Composite. 25 g RSP was weighed into beaker and then 10 mL water was added, followed by stirring for 5 min so that RSP was uniformly moistened. Thereafter, certain amount of CC was weighed and added into moistened RSP, followed by stirring for 5 min. A 125 mm×125 mm×2 mm iron mold was prepared by brushing a layer of dimethicone oil onto the top and bottom surfaces of mold and laying a sheet of WP on bottom surface. Then the mixed raw material was put in the prepared mold, another sheet of WP was laid on mixed raw material, upper mold plate was set and then was hot-pressed on MZ-3012 machine at 10MPa pressure. After cooling to room temperature, the product was taken out to be tested.

Measurement of Composite. 2.5 cm wide strips were cut out from products to test tensile performance. Tensile strength and tensile elongation were measured on MZ-2000D.D1 electronic universal testing machine (Mingzhu test machine company, Jiangdu, Jiangsu, China) with tensile speed as 5 mm/min. Square with side length as 4 cm was selected from products and its four vertices were selected as hardness-measurement points. The four vertices were labeled respectively as point 1, 2, 3 and 4 according to hardness-increasing order. Shore hardness was measured with LX-A Shore A type durometer (Mingzhu test machine company, Jiangdu, Jiangsu, China).

Results and Discussion

The Effect of CC Ammount on the Strength of Composite Materials. A series of RSP/CC/WP composites were prepared by adding different mass of CC and hot-pressing at 130℃ for 10 min. The change of tensile strengths with the increase of CC amount was drawn in Fig. 1. It can be seen that tensile strength increases with the increase of CC content. The tensile strength arrived at 4.2 MPa when CC amount was 20g and was 64% higher than that at 5 g CC. In RSP/CC/WP composites, RSP can not bind each other but is bond by CC. With the increase of CC content, more binding points resulted among RSP. RSP/CC/WP composites were easily taken out from mold and composite samples were all whole due to the application of WP.

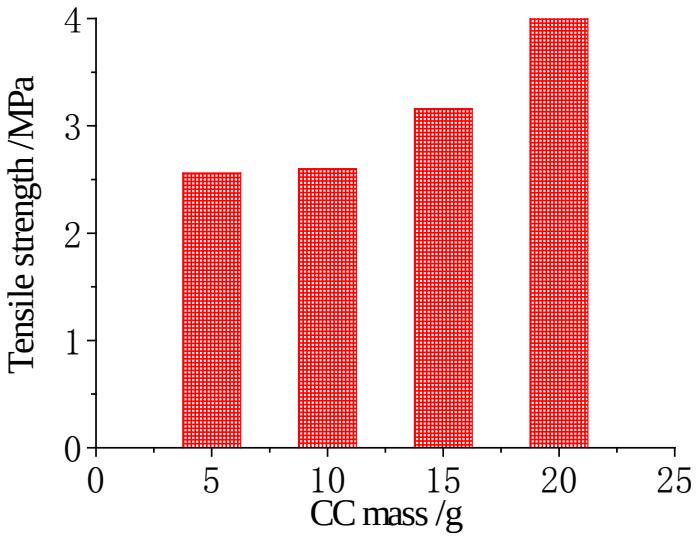

Fig. 1 The tensile strength of composites at different CC amounts.

The change of strength at tensile break with the increase of CC amount was drawn in Fig. 2. It can be seen that as tensile strength, strength at tensile break also increases with the increase of CC content. The maximum arrived at 4.1 MPa when CC amount was 20g and was 1.61 times higher than that at 5 g CC. Strength at tensile break fundamentally was less than tensile strength at all CC amounts, which indicating that the composites had a little toughness. With the increase of CC amount the difference of strength at tensile break and tensile strength decreased.

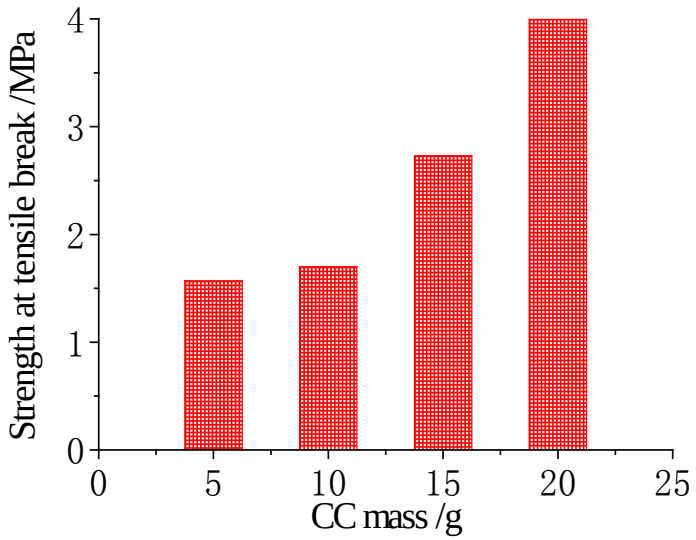

Fig. 2 The strength at tensile break of composites at different CC amounts.

The Effect of CC Content on the Stretch of Composite Materials. The change of tensile stretch with the increase of CC content was drawn respectively in Fig. 3. It can be seen that tensile stretch increases with increasing the CC amount. When amount of CC mass was changed from 5 g to 20 g, the tensile stretch changed from 8.7% to 10.8%. The similar change rule of strength and stretch indicated that high strength was in favor of high stretch. But it should be pointed that tensile stretch of RSP/CC/WP was relatively low.

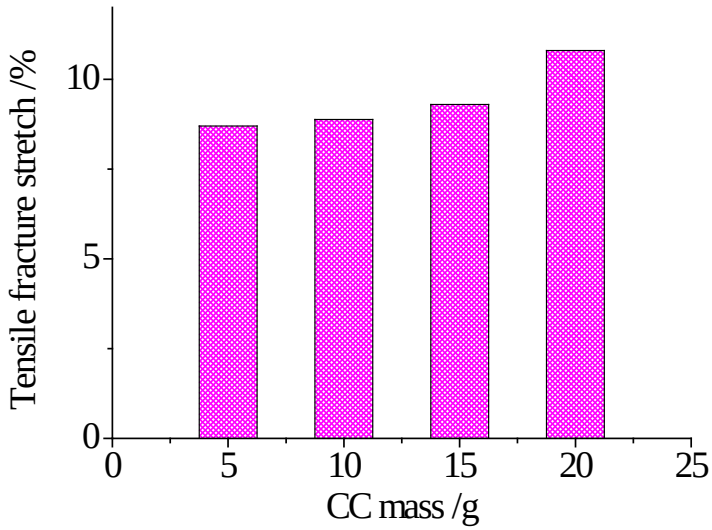

Fig. 3 The tensile stretch of composites at different CC amounts.

The Effect of Hot-pressing Time on the Stretch of Composite Materials. A series of RSP/CC/WP composites were prepared by hot-pressing for different time at 130℃ with 15 g CC amount. The change of tensile strengths with the increase of hot-pressing time was drawn in Fig. 4. It can be seen that tensile strength increases with the increase of hot-pressing time. When hot-pressing time was changed from 6 min to 12 min, the tensile strength increased from 2.5 MPa to 4.6 MPa and the increasing ratio was 84%. Long hot-pressing time was favorable for CC diffusing among RSP, which resulted in that more binding points formed among RSP.

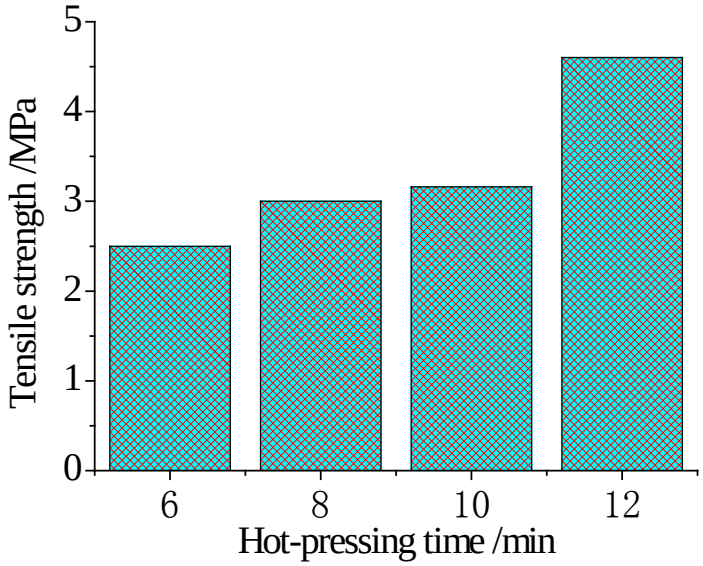

Fig. 4 The effect of hot-pressing time on tensile strength of composites.

Summary

WP is a useful auxiliary material when straw based materials are made by hot-pressing method. It played versatile roles in the preparation of RSP/CC composites. Firstly whole composite samples were obtained; secondly the samples were easily taken out from mold; thirdly WP showed certain strengthen action. Otherwise WP was an easily available waste resource. Therefore WP was worth deep developing in the preparation of straw based composites.

Acknowledgements

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