Preparation and Performance of SGS/Starch Composite

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Abstract. A novel environmentally friendly composite was prepared with short-chopped grass segments (SGS) and starch by hot-pressing method. The effects of ratio of raw materials and hot-pressing temperature on the performance of composites were studied. Results showed that the tensile strength increased with the increase of starch content. When starch content was 50%, the tensile strength of composite was 3.24 times higher than that at 20% starch content. The tensile stretch first increased and then decreased with increasing starch amount. Stretch at maximum tensile force of composites was very near tensile stretch. This indicated that SGS/starch composites have low toughness. The hardness of composites at any starch content showed certain fluctuation and lay between 80 and 92. The tensile strength of composites first increased and then decreased with increasing hot-pressing temperature. When hot-pressing temperature was 140℃, tensile strength arrived at 3.21 MPa.

Introduction

Plant straw is a kind of important renewable natural resource. It can be used as fuel, building materials, woven materials and paper-making materials etc. But now with the economical and social development, many uses of plant straw disappeared, which resulted in the relative surplus of plant straw. Under this circumstance, a lot of plant straw was burnt in the fields and brought about serious gas pollution and resource waste. So it is imperative to develop novel straw-utilizing methods.

Making environmentally friendly materials is such a novel straw-utilizing method. Environmentally friendly materials prepared with plant straw as raw materials have a wide range of uses, for example, preparing packaging materials, furniture and toys. 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.

Except for crop straw, other plant resource also can be used as raw materials for preparing environmentally friendly composite, for example, wild grass. Grass is also a kind of abundant resource, has good strength and toughness, and can be used as an alternative raw material for crop straw. Studies on preparing composite with grass were less reported. So SGS/Starch Composite was prepared and characterized. Starch is also a renewable resource. The combination of SGS and starch can endow composite with complete degradability and high environmental friendly property.

Materials and Methods

Materials. Grass was obtained from Jiujiang University's lawn and was dried in the sun before application and then was cut into about 1.5 cm long segments to prepare SGS. Water was from urban water-supplying system. Dimethicone oil was purchased from Xilong chemical company (Shantou, China) and was used as received.

Preparation of SGS/Starch Composite. Different amounts of SGS were weighed into beaker and then 10 mL water was added, followed by stirring for 5 min so that SGS was uniformly moistened. Thereafter, starch was weighed and added into moistened rice straw, followed by stirring for 5 min. The total mass of SGS and starch was kept as 30 g. 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. Then the mixed raw material was put in the lower mold, upper mold plate was put on the lower mold and then was hot-pressed on MZ-3012 machine at 10MPa pressure. The mold was taken from hot-pressing machine. After cooling to room temperature, the product was taken out to be tested.

Measurement of Composite. Measurements of tensile performances and hardness were carried out as previously reported[1].

Results and Discussion

The Effect of Starch Content on the Strength of Composite Materials. A series of SGS/starch composites were prepared at different mass contents of starch. The change of tensile strengths with the increase of starch content was drawn in Fig. 1. It can be seen that tensile strength increases with the increase of starch content. The tensile strength at 50% starch content arrives at 3.01MPa, 3.23 times higher than that at 20% starch content. In SGS/starch composites, SGS can not bind each other but is bond by starch. With the increase of starch content, more binding points resulted among SGS.

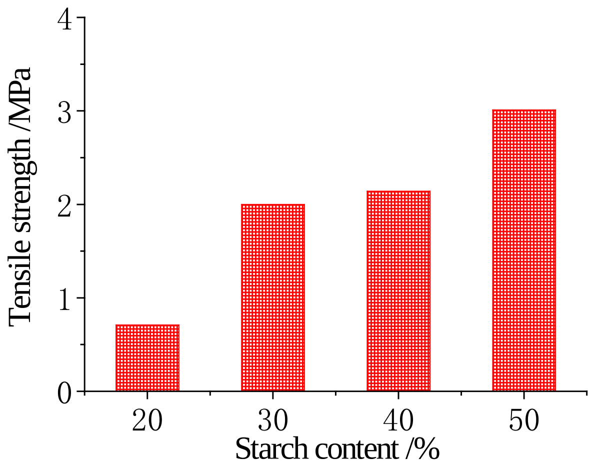

Fig. 1 The tensile strength of composites at different starch contents.

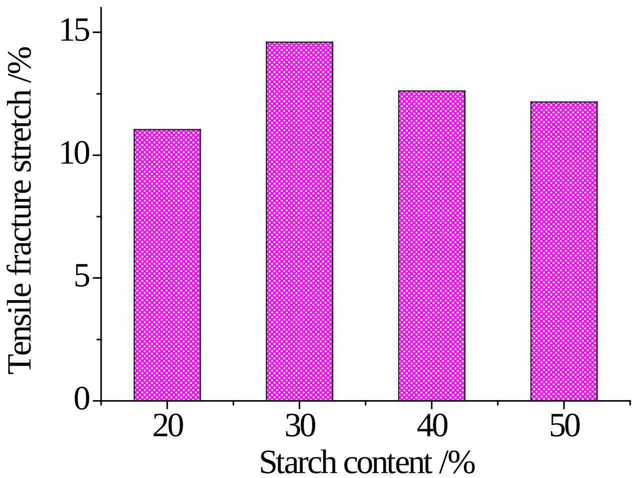

Fig. 2 The tensile stretch of composites at different starch contents.

The Effect of starch Content on the Stretch of Composite Materials. The changes of tensile stretch and stretch at maximum tensile force with the increase of starch content were drawn respectively in Fig. 2. and Fig. 3. It can be seen that two kinds of stretches first increase and then decrease with increasing the starch amount. When starch content was low, composite had low strength and was easily disrupted during tensile course. When starch content was too high, SGS was more completely bond, resulting that composites showed certain rigidity. It can be seen from Fig. 3 that stretches at maximum tensile forces of composites were very near tensile stretches at all kinds of starch contents. This indicates that SGS/starch composites have low toughness because starch is a kind of rigid material due to its strong intermolecular hydrogen bonds.

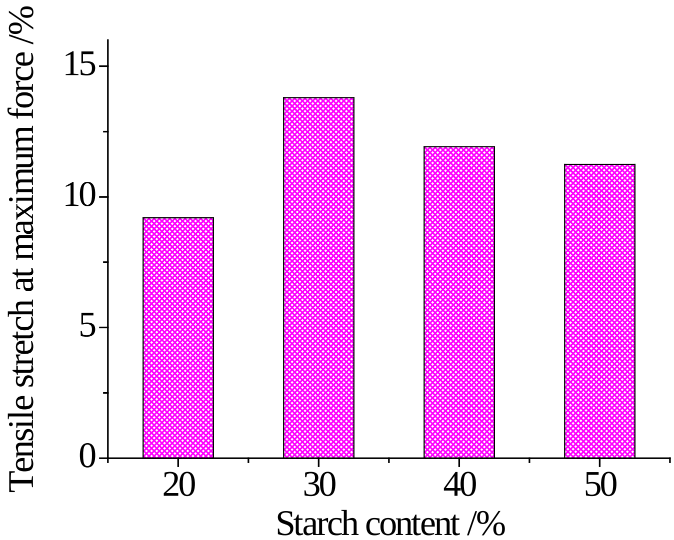

Fig. 3 The tensile stretch at maximum tensile force of composites at different starch contents.

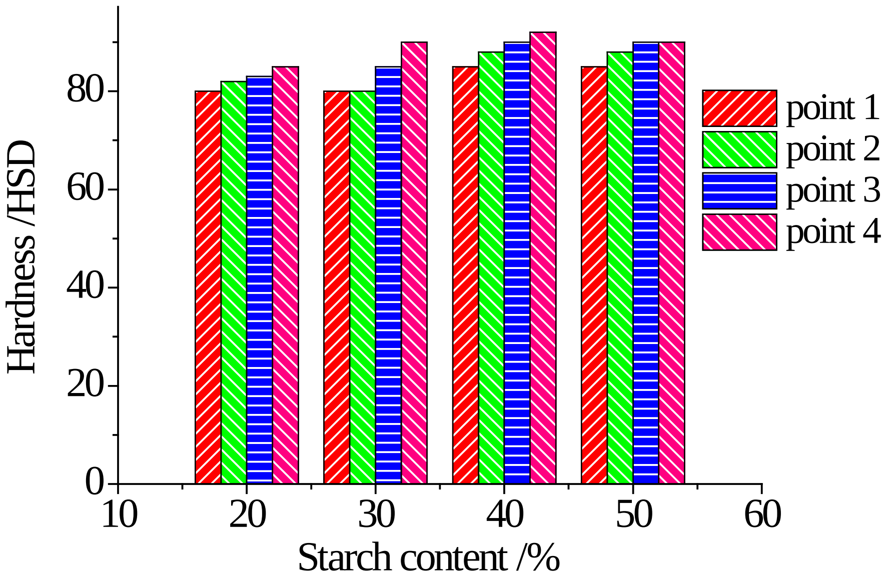

Fig. 4 The hardness of composites at different starch contents.

The Effect of starch Content on the Hardness of Composite Materials. At different starch contents, the hardness of composites was depicted in Fig. 4. It can be seen that the hardness of composites at any starch content showed certain fluctuation and lies between 80 and 92. This indicates that the surface of composites was not even and flat. Negligible difference exists in every composite except that composite had slightly low hardness when starch content was 20%. At other starch contents, hardness fluctuating ranges were similar. So starch content had no obvious effect of hardness of composites.

The Effect of Hot-pressing Temperature on the Stretch of Composite Materials. A series of composites were prepared at different hot-pressing temperatures and the effect of hot-pressing temperature on strength was drawn in Fig. 5. It can be seen that the tensile strength of composites first increases and then decreases with increasing hot-pressing temperature. Too high hot-pressing temperature harmed the structure of SGS and too low hot-pressing temperature resulted in incomplete adhesion between SGS. When hot-pressing temperature was 140℃, tensile strength arrived at 3.21 MPa.

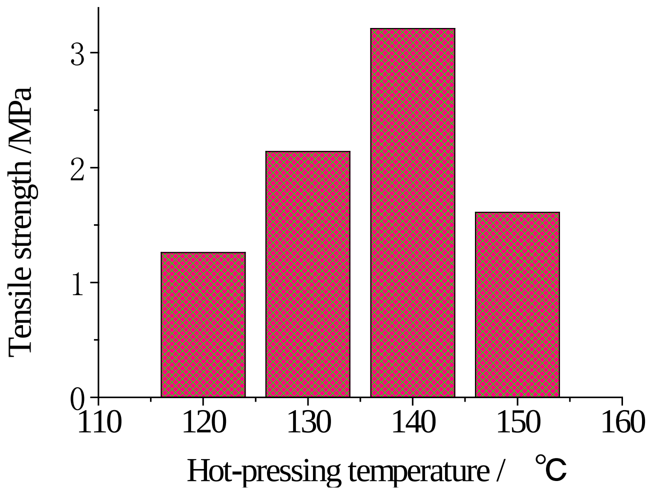

Fig. 5 The effect of hot-pressing temperature on tensile strength of composite.

Summary

SGS/starch composites were successfully prepared by hot-pressing method. Ratio of raw materials and hot-pressing temperature obviously affected the tensile strength of composites. But hardness of composites less affected by above factors and hardness of composites was uneven. All in all, the strength of SGS/starch composites was not high and needed deep improving.

Acknowledgements

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