# The Research of Bamboo Pulp Buffer Packaging Material

**Liu Ye, Qin Shuyan, Shi Zhengying**
*Package Department Zhejiang Sci-Tech University HangZhou, China*
*Email*: *Liuyehz@163.com*

**Abstract:** Fiber foaming material is the one developed in recent years which characterized with no environmental contamination, simple processing, low cost, rich in raw stuff and so on., And it can replace EPS as cushioning mat. Also it can be used as the cushioning material to package the big packages. Studying on the resourceful Phyllostachys edulis fiber, discussed the foaming material using the bamboo pulp and other assistants. analyzed the product's structure and mechanical properties, be making a good base for producing the new cushion packaging material, which satisfy the requirement of green environmental protection. Mainly studied on some aspects as follows: analyzed the characters of the bamboo powder and bamboo pulp. Compared their products and got that the product using bamboo pulp had better performance. using the experiment method to confirm the parameter of material granularity, the temperature, the dryness, the incision etc; to determine every kind of the additional materials and their proportions; to research the inside bond and exterior process mechanism; studying on the high efficiency and no polluting mechanism to determine the parameter of foaming technics.

**Keywords:** Cushioning Material; Cushioning Performance; Bamboo Pulp; Foaming Mechanism; Cell Structure;

## 1. Introduction

At present, the graveness challenge that human facing is resource and environment. The buffer packaging materials use macro kinds of EPS have already became pricking up the world's circumstance crisis. Research And Development new type materials which can degrade, recycle and reuse are staring us in the face.

The main substitute products of foam plastics cushion packaging materials are pulp moldings、plant-fibre products and so on. The main materials of foam plant-fibre products are plant-fibre stuffs and starch additives, this product doesn't pollute environment, the facture technology is simple, the whole costs are cheap, source of raw materials are wide, the manufacture time and period are short, the capabilities of resisting vibration and enduring impulsion are better than pulp moldings, preventing static and causticity performances are better than EPS. With the progress of foaming technologies, this material can not only facture shockproof cushion pad, but also replace EPS as filling granule, the effect is as well as EPS.

In numerous plant-fibres, bamboo-fibre species have the best potential exploitation. Its performance is stabilize, density is low, it has favourable breathe freely character, inimitable re-elasticity character, drinking water blinkly, it also has quite strong portrait and landscape orientation intension etc. Specific-rigidity and specific-strength are higher than woods and common steels.

Besides, bamboo itself has bacteria resist, because this performance that using bamboo packaging materials, we shouldn't worry about the material providing, but there aren't pollution during the producing and using processes, thereby it will favor for protecting environment.

## 2. Experimentation

Using the bamboo pulp and other assistants and analyze the product's structure and mechanical properties.

### 2.1. Main Technology Flows

### 2.2. Mainly Studied

1) *Analysed the Characters of the Bamboo Powder and Bamboo Pulp.*

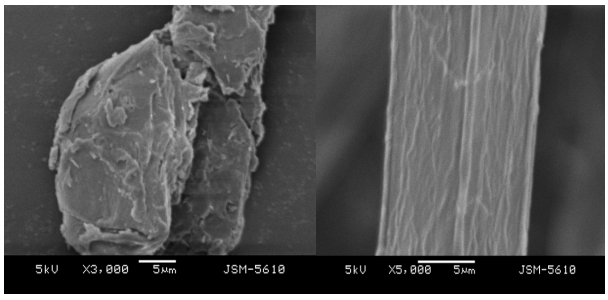


**Figure 1. Compared the bamboo powder's fiber and the bamboo pulp's fiber in the SEM.**

The main components of bamboo fiber are cellulose, hemicellulose and lignin, the whole bamboo is made up of 50%-70% entirely cellulose, 30% pentosam and 20%-25% lignin. Bamboo fiber are slightness, the length breadth ratio is between 120-200, the cliff is thick and the cavity is small, the proportion is large, the fiber is more straight and hard.

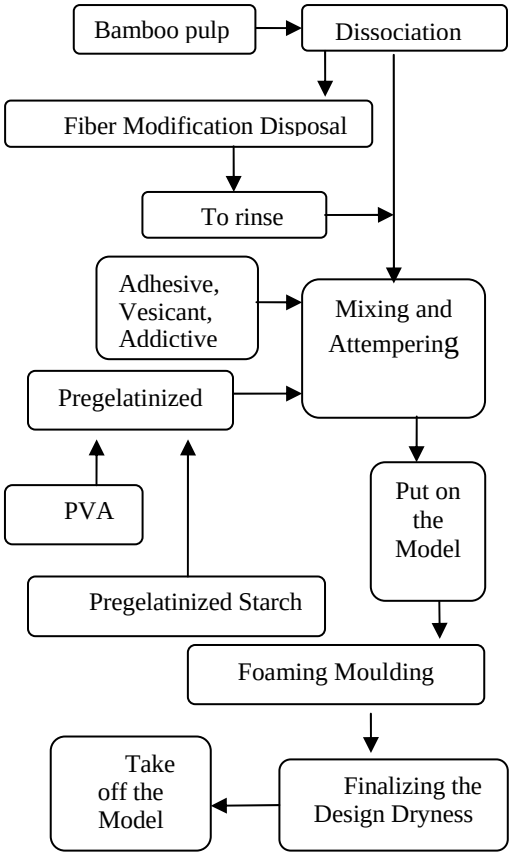


**Figure 2. The flow process chart of the exprement's Figure.**

Compared the Fig. 2 and Fig. 3 we know that the bamboo powder's fiber is short than the bamboo pulps'. There are some impurities and with cracks on the surface. SEM images the bamboo pulp's fiber is long - thin and smooth, The delicate fiber is structure

Compared their products and got that the product using bamboo pulp had better performance.

2) *Used NaOH solution for surface treatment to improve the system consistency. Disscused the effect on the product's performance of different treatment times.*

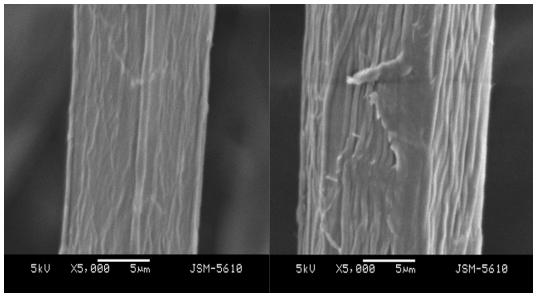


**Figure 3. Compared before and after surface treatment in the SEM.**

The surface treatment can remove gum and part of the lignin, hemicellulose, so that the fibers refined decomposition and break the hydrogen bonds between cellulose molecules, so that the fibers become flexible.

3) *Based on the orthogonal test, changed the every constituent's contents to analyse the their effects on the product.*

## 3. Key Technologies

### 3.1. Foam Technology and Foam Parameters

Though analysis on the three modes: chemical foam-

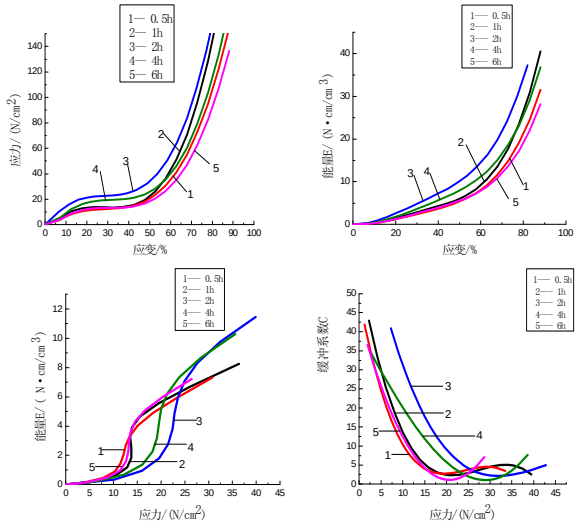


**Figure 4.** The best time of surface treatment

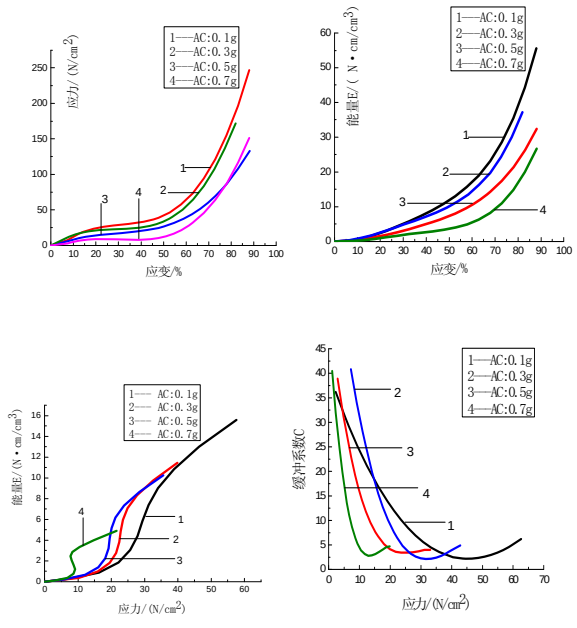


**Figure 5. AC of the optimum dosage**



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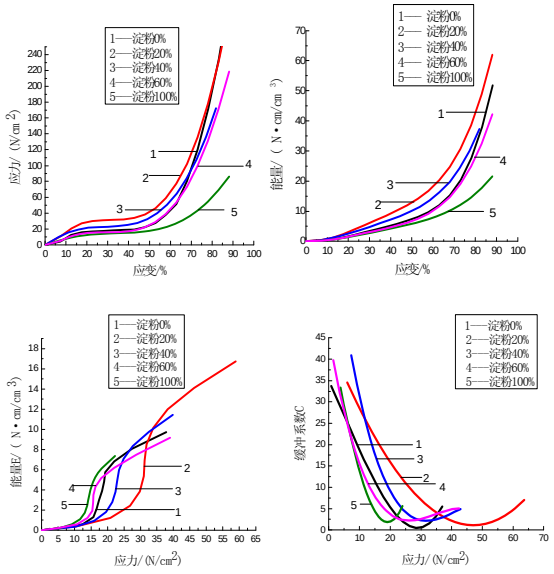


**Figure 6. The optimum ratio of starch**

ing, physical foaming, mechanical foaming, according to the material characteristics and molding methods, choosing the method of chemical foaming.

Though experiment to confirm and optimize vesicant, after vesicant mixed, combining material state(quantity of containing water), molding technology (temperature), molding method, dryness method, then confirm prescription. Finally make sure a vesicant assemble which suit for the technics requirement, sparkle large air bubbles, furthermore, stabilize. Comparing plant-fibre foam materials and foam plastics, the former manufacture is simple, doesn't need time after time foaming and cooling.

### 3.2. Interior adhesive and exterior disposal modification methods

The character of savageness plant-fibres will have biggish difference while choosing botanic different parts, producing place and pretreatment. Through research on fibre character, fibre disposal method, the connection between fibre fabric and performance, then traversing though chemical and physical modification methods to dispose the exterior of the fibre; analysing the infection factors on bamboo fibre such as: each additives' proportions, temperature, concentration etc to improve bamboo-fibre resistance to pressure stress and its cushion performance.

The most important reason of exterior disposal is to improve compatibility and penetrability between adhesive and fibre, but the great molecular weight adhesive has the poor penetrability. Alkalescence liquor exterior disposal has big infection on great molecular weight adhesive, but small infection on less molecular weight bond, so adopting this kind alkalescence liquor to dispose bamboo-fibre exterior will greatly boost up the penetrate capability of great molecular weight degradation adhesive.

## 4. Results and Discussions

### 4.1. *Structural characterization of foam*

Structural characterization of foam means the foam main macro-and microscopic structures

1) *the foam main macro*

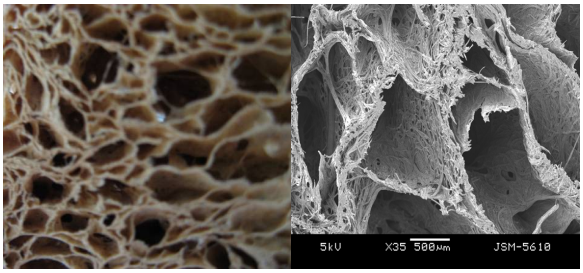


**Figure 7. The foam main macro-and microscopic structures**

As the cell expansion foam products have a certain ratio, the cell size uniformity, in order. but the surface of thick foam, foam layer is also more compact, This is because the heating, faster than the loss of surface water, so that the driving force of the cell swelling decreases. The dense skin layer on the foam density and elasticity has important influence. Its existence makes the overall foam density, elasticity decline, Therefore, to ensure uniformity of foam as a whole, performance in the test surface when removed.

2) *the foam microscopic structures*

The cell shape is polygonal can be seen from the Microscope diagram, multi-hole is a form of. Under the action of the adhesive, fiber bonding condition between the good, the cell wall smooth, with a certain thickness. And it can see between the fiber and the fiber aspect to staggered, three-dimensional network structure formed in the SEM. Effectively wrap up the gas blowing agent decomposition. Meanwhile, the bubble tension on the fiber has "hold up" effect, These two effects together form a "three-dimensional network". it again to the role of adhesives and other materials, under certain intensity, so that foam can handle the physical shock.

### 4.2. Bamboo and other buffer materials Comparison of Dynamic Buffer

Based on the principle of the dynamic impact test comparing the maximum acceleration - pressure curves by changing the drop height, it was found to increase with the drop height, the maximum acceleration of the minimum increases, the curve shift to the upper left the measured maximum acceleration - pressure curves and other common cushioning material to compare at 450mm height. Found that the cushioning material prepared with bamboo maximum acceleration at 2.6-5.3kPa range of static stress. it 's small than the EPS, EPE,

shows bamboo foam absorbed more time the energy and bamboo foam cushioning than EPS, EPE good.

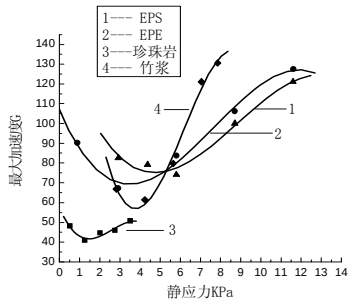


**Figure 8. The acceleration and static stress values of the lowest point on the $G_m - \sigma_{st}$ curves of the cushioning materials**

### 4.3. Analysed the relationship between microstructure parameters and mechanical properties qualitatively.

Mainly analysed the effects of cell shape, cell diameter, cell wall, cell distributing and cell flaw on the mechanical properties. Generalized that the bigger cells can deforme much than the smaller ones and absorb more energy. But the smaller cells can improve the deform uniformity.

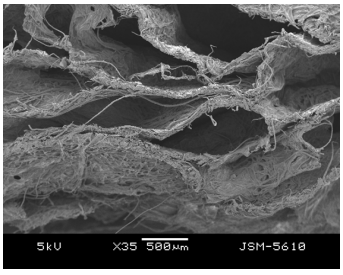


**Figure 9. The cell structure after compress in the SEM**

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978-1-935068-36-5 