Research on Warmth Retention Property of Far-infrared Shoe Lining Material

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Abstract：In order to improve warmth retention property of shoes lining material, the method of adding dispersant and cutting emulsification was used to disperse the far infrared powder firstly in this paper, and then the dipping treatment was used to handle the cotton fabric for shoe lining. Finally, the warmth retention property and durability of far-infrared shoe lining material was tested by using the method of temperature rising. The result showed that warmth retention property of cotton fabric of shoe lining rose distinctly after being handled by far-infrared reorganization fluid, meanwhile, the physical and mechanical property of fabric changed little, and then could meet the demand of fitting.

Key words：far-infrared powder; shoe lining; warmth retention property

1 Introduction

With the people's living standards improving, more and more people begin to pay more attention to the improvement of the life quality. The emergence of thermal underwear, winter clothing has changed the past bloated form, therefore, warm clothing make people become more relaxed. In the cold season, in addition to warm clothing, people have a higher demand of the boots, not only the high heat value, but also light, and easy to wear at events.

Far-infrared shoe material is created in such a case. The far-infrared shoe material has such advantages as following: good anti-bacterial, promoting blood circulation, promoting metabolism, elimination of fatigue and other health care performance [1]. Meanwhile, it hasn't any side effects, therefore it meets the demand of health requirements of many people, and it will have good market demand and prospects for development. On the other hand, the far-infrared shoe materials possess high technical content and high added value features. The production of such products can increase the effectiveness of shoe-making enterprises, and promote the shoe industry towards the development of broader areas.

2 Experimental

2.1 Materials

The materials used in this experiment are shown in Tab.1.

Tab. 1 Materials

Chemicals	Norm	Origin place
far-infrared nano-composite powders	100nm	Shandong Zhengyuan nanomaterials engineering Co., Ltd.
SHMP	AR	Tianjin Fu Chen chemistry reagent plant
Shoe material of white cotton cloth	-	Wenzhou Dongyi shoe Co., Ltd.
Adhesive stamp	TYLC-68769	Hangzhou Ruolin chemical Co., Ltd.

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2.2 methods

2.2.1 Far Infrared Finishing Preparation

1) The percentage of each component of finishing solution is as follows: Far-infrared composite powder 5%, 0.1% SHMP, printing binders 2%, adjust the pH value of finishing solution is from 9 to 10.

2) The finishing process of far Infrared cloth of shoe lining material[3] is as follows: infiltration (far-infrared liquid finishing, 10min) → dry rolling (rolling over the rate of 75%) → dry (90℃, 20min) → curing (150℃, 3min).

2.2.2 Thermal insulation properties of far-infrared shoe materials testing

Sample of Far-infrared composite finishing powder processed, after drying and constant weight, measuring its thermal performance. Test methods [4] are as follows:

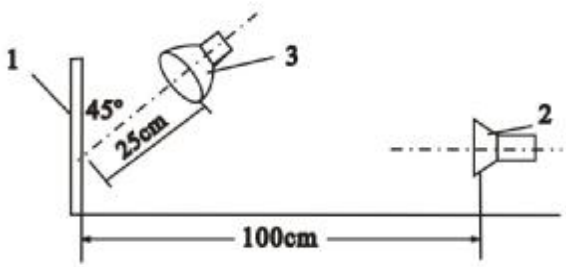
1) Cutting each piece of sample as the size of 10cm × 10cm, repairing the defects if its surface.

2) Fixing the sample in the wire framework, maintaining the same elastic of each sample, the fabric should be formed at the same time.

3) Putting the infrared light to 25cm away from the specimen center with 45° angle, the non-contact infrared thermometer is in front of the specimen.

4) Recording the initial temperature of shoes lining material before opening the infrared light.

5) Opening the infrared light, testing the sample temperature at every 1min with the non-contact thermometer and record the temperature, recording 15min continuously.



1-Shoe lining material; 2-Far-infrared Thermometer; 3-Infrared light

Fig. 1 Temperature rising test

3 Results and discussion

3.1 Thermal performance test

In accordance with test method of 2.2.2, testing the temperature rising performance of the sample [5], the test results shows in Fig.2:

1 #: shoe lining material without far-infrared liquid finishing processing.

2 #: shoe lining material with far-infrared liquid finishing processing.

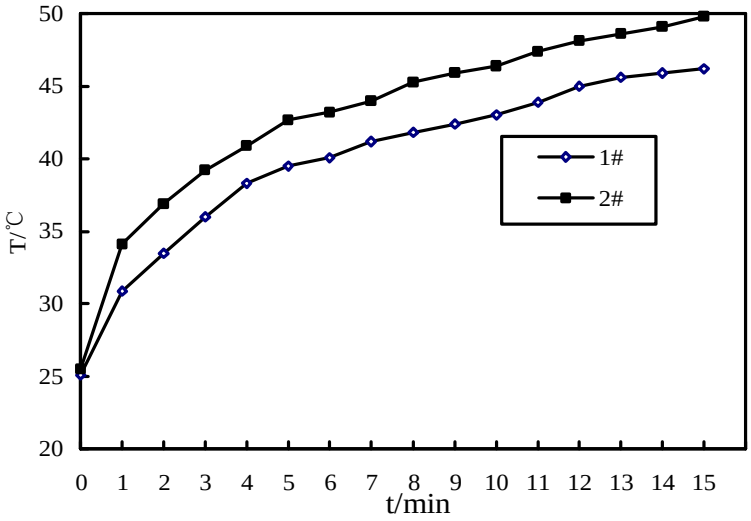


Fig. 2 Temperature rising before and after finishing of far infrared solution

As can be seen from Fig.2, the initial temperature of sample 1 # and 2 # are 25.1℃ and 25.5 ℃ before infrared light exposure. It can reflect that the far-infrared shoe lining material has a good thermal performance from the data analysis, it can absorb the heat outside world and reserve it, and makes the surface temperature of shoe lining material 0.4℃ **higher than that** has not been processed by far-infrared liquid.

At the same time, the beginning surface temperature rising difference of the two samples is quite clear. The temperature rise(ΔT) of sample 2 # and 1 # has the difference of 2.8℃ at the time of the first minute, Two minute later, the temperature rise difference is larger than before. Sample 2 # temperature rises faster with the infrared light irradiation at the same time. The ΔT of 1 # and 2 # are 21.1℃ and 24.3℃ at the time of the fifteenth minute.

The principle of thermal radiation can be used to analysis this phenomenon, for the sample 2#, when the heat reaches the shoe lining material, part of them reaches the receiving end, another part of them is absorbed by the far-infrared composite powder of shoe lining material, and then the far-infrared composite powder radiate the heat out, thus causing the heat reached shoe material is radiated back to the composite powder source. As for the sample 1#, the heat is only through the shoe lining material reaching the receiving end. The radiation from the heat source does not re-radiation back to the shoe material. Therefore the temperature rising of sample 2# is higher than that of sample 1# at the same time.

3.2 Durability test

3.2.1 Baptist khan resistance test

It tests the temperature rising performance of far-infrared shoe lining material after sweat soaking for 3 hours, the results are shown in Fig.3.

As is shown in Fig.3, the temperature rising performance of far-infrared shoe material soaked by the sweat has dropped a little, but it also can maintain a higher temperature rise performance after 3 hours sweat soaking. Here is the reason: sweat can destroy the fastness between far infrared powder and shoe lining material, therefore the content of far-infrared powder reduced in it, thereby makes influence on its temperature rise performance.

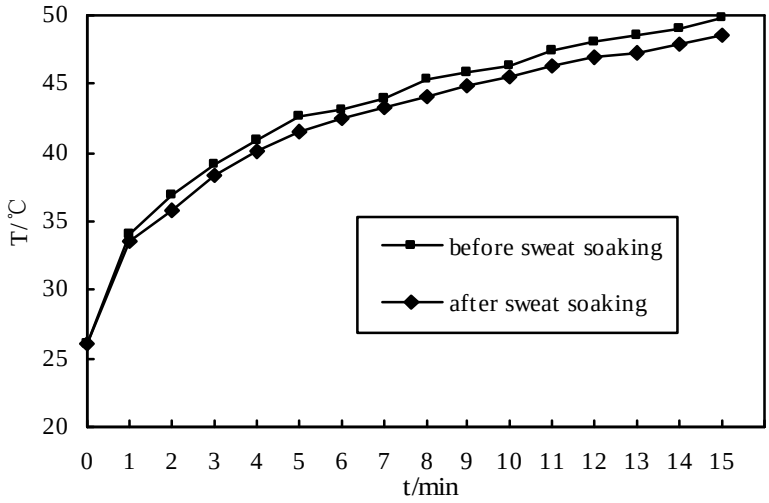


Fig. 3 Temperature rising before and after sweat soaking

3.2.2 Wet and dry wiping resistance

Testing the temperature rising performance after dry wiping and wet wiping 50 times respectively, results are shown in Fig.4.

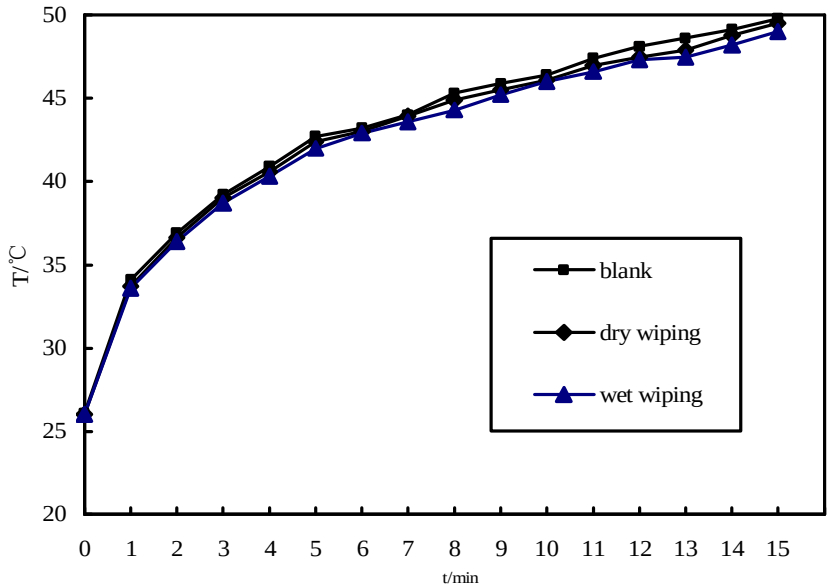


Fig. 4 Temperatures rising before and after wet or dry wiping

As is shown in Fig.4, despite the decline in the temperature rising performance, the far-infrared shoe lining material still has good performance of the temperature rising after wet and dry wiping treatment. In contrast, wet wiping influences more than dry wiping on the temperature rising performance of shoe lining material. This is because in contrast with dry wiping, shoe lining materials are soaking the water and increasing the degree of abrasion in the process of wet wiping, thus affecting the warmth retention performance of composite far-infrared powder in the surface of the shoe lining material. Therefore, wet wiping has a greater impact on the temperature rising performance than that of dry wiping.

3.3 Physical and mechanical properties test

Far infrared powder which is tiny solid particles is used in the Finishing process, and in finishing process they accompanied with stretching actions, therefore, it could have an impact on fabric breathable performance. The results of physical properties are shown in Tab.2.

Tab. 2 Physical properties changes of shoe lining material

Item	shoe lining material without far-infrared liquid finishing processing		shoe lining material with far-infrared liquid finishing processing		Rate of change (%)	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
Ventilation rate （mm/S）	391.8		373.5		−4.67	
Tearing force （N/mm）	27.63	31.25	26.96	28.4	−2.42	−9.12

From Tab.2 we can see that the permeability of shoe lining material which is treated by far-infrared composite powder finishing fluid is essentially the same, meanwhile, tear strength is slightly lower. The reason is that the inorganic finishing powder fluid-filled space of some fibers; In addition, the alkali that the collation solution contains can damage the molecules of cotton fiber, but will not seriously affect the application of products.

from the testing on its temperature rising performance and the physical and mechanical properties, It can be inferred that the finished shoe lining material has good warmth retention property, its mechanical properties change little before and after finishing, even if the change is also acceptable. Therefore, from the two aspects of function and wearing, the finishing process is very reasonable.

4 Conclusions

(1) Temperature rising performance of shoe lining material increase significantly after it is collated by finishing solution which add far-infrared composite powder, this indicate that collated by the far-infrared liquid handling can significantly increase the thermal isolation performance of shoes lining material.

(2) After the far-infrared shoe lining material is soaked by the sweat, its warmth retention property have a downward trend, but it has little influence on then, it still remains high temperature rising performance after sweat soaking.

(3) Despite the decline in temperature rising performance of far-infrared shoe lining material after dry and wet wiping treatment, it still has good performance of temperature rising, the influence is smaller than that of sweat soaking.

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