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Study on Improving Sewing Damage of Cuprammonium Fabric

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Abstract. Cuprammonium fibers are usually used to prepare high-grade silk fabrics as its thin, soft, and suitable luster characters. Because of its smoothy surface of one single filament, which made the coefficient friction is lower than other common fibers, like cotton, hemp. The cuprammonium filament fabrics are apt to be punctured during the manufacturing processes of garment. Which damages the surface luster of the fabrics and seriously affects the quality of the finished garment. A method of adding a double-sided fusible interlining to the middle of two layers cuprammonium fabric to enhance the cohesion force and improve the suture damage of the fabric is introduced in this manuscript. A sewing damage measurement system is set up to measure the improving effect. Sample with or without treated under different circumstances the effects of sewing damage are discussed. Fixing the needle stitch length as 2.0 mm, the effect of the wider adhesive interlining on improving the sewing damage is better. And the width of adhesive interlining is 1.0 cm, the longer stitch length is better. An excellent improvement is found to improve the stitching damage of this type of fabric, thereby improving the quality of the garment.

Keywords: Cuprammonium fabric; Sewing damage; improving method.

1. Introduction

With the development of economy and the wide spread of the United Nations Sustainable Development Goals (SDGs)[1], the recycling and sustainable development of the earth's resources have become the focus of attention from all walks of life in the world, and many ecological and environmental problems in today's society are getting more and more attention. The sustainable development of the garment industry mainly refers to the integration of "green" and "environmental protection" clothing design concepts into it to further promote the transformation and upgrading of the garment industry [2]. With the national attention to recycling economy, the pace of development of recycled fiber is getting faster and faster [3]. Cuprammonium fiber is a kind of regenerated cellulose fiber. The preparation of it is to dissolve natural cellulose raw materials (such as cotton) in a copper hydroxide concentrated ammonia solution or an alkaline copper salt solution to form a spinning solution. The spinning solution is placed in a coagulation bath through a spinneret, and the molecular chemical substances of cuprammonium cellulose are decomposed into hydrated cellulose, and cuprammonium fiber is obtained after hydrated cellulose treatment.

Cuprammonium fiber become more and more popular because of its skin-friendly, air permeability, antistatic, and other good characters. The friction between the yarns of the cuprammonium fabric is small as the smoothy surface of any single fiber. Therefore, in the garment sewing processes, the needle tip is easy to take away single or multiple yarns of the fabric, resulting in the laddering of single yarn or multiple yarns [4]. On the other hand, people from all walks of life have joined the big team of environmental protection, environmental protection materials are emerging in endlessly. Clothing is the first of human food and clothing live line is also inseparable from the human cannot run away from one of the largest material consumptions[5]. Under the guidance of people with enhancing the commence sense of environmental protection and establishment of an environment-friendly society, cuprammonium fabrics have bright prospects for development in marketing [6]. Cuprammonium fiber manufacturing enterprises hope that the fabric will develop from a single garment lining to a garment fabric[7]. In the following decades of development, part of western culture gradually entered China's clothing industry, and people had more new understanding and understanding of clothing design, whether in the whole clothing

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design, or the use of materials have new breakthroughs and understanding. In the process of development, fashion design should pay more attention to the effective integration with the corresponding environment and break the shackles of traditional ideas [8].

Due to the poor stitching performance of cuprammonium fabric, it is easy to have different degrees of laddering in the process of fabric stitching, which seriously affects the quality of the finished garment produced by this fabric. Therefore, this research hopes to improve the sewing performance of light filament cuprammonium fabric through the improvement of basic sewing process, to improve the garment quality of such fabrics.

2. Experiment

2.1 Material

The cuprammonium twill fabric (with warp and weft yarn density of 50D*75D) was provided by Shanghai Nengtai Textile Co., Ltd, China. The light Chiffon double-sided fusible interlining (hd9030 with density of 30D*30D) is provided by Changshu New Soochow Garment Accessories Co., Ltd, China. The electric iron is Philips Easy Speed Plus. And the sewing machine is the computer flat DDL-8900H produced by Dongguan Xingchi Sewing Equipment Co., Ltd. China.

2.2 Sample Preparation

Firstly, the damage situation of the sewed fabric with adjusting the stitch length were studied. The squared fabrics lined face to face with a size of 100 cm×50 cm was sewed by adjusting the stitch length of 1.0, 2.0, 3.0 mm, respectively. For the garment industry, the strength of the clothing construction sewed with a needle stitch length of 3.0 mm is very small, and it is easy to open seams. Therefore, the stitch length more than 3.0 mm is seldomly applicated, so it doesn’t available in our experiments. These samples were marked as A00, A10, A20, and A30 for the non-sewn ones, 1.0, 2.0, and 3.0 mm, respectively.

Lining and ironing (with 135-140℃, pressure 0.8-1.2 kg/cm2) the double-side fusible interlining in the middle position of the two layers of cuprammonium twill fabrics and then sewing on it. Different widths of interlining to the squared fabrics and then sewed it to observe the improvement effect. The distance between the seam line and the edge of the fusible interlining is defined as the seam margin. The seam margin was fixed as 0.5 mm, samples were sewed with stitch length of 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, 3.0mm were named as B10, B15, B20, B25, and B30, respectively. Then fix the stitch length as 2.0 mm, and changed the seam margin from 3.0 mm, 5.0 mm, 10 mm, 15 mm, 20 mm, the samples were also correspondingly named as C03, C05, C10, C15, and C20. Each sample’s information was shown in table 1.

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Table 1. Sample information.

Sample	Seam margin (mm)	Needle stitch length (mm)	Fusible interlining
A00	--	--	No
A10		1.0	
A20		2.0	
A30		3.0	
B10	5	1.0	Yes
B15		1.5	
B20		2.0	
B25		2.5	
B30		3.0	
C03	3	2.0	
C05	5		
C10	10		
C15	15		
C20	20		

2.3 Design and Detection of Light Transmission Defect Detection Device

The detection facility was equipped and was component of a camera box (a cubic with each length 60×60×60 cm and all surfaces were covered), a fixed image capture camera, and a back panel of the photography box. The back panel contained a LED light-emitting board, a layer of light diffuser, and a suitable rectangle detection window (8 cm×2 cm) for a fabric detected. The transmission of light through the fabric could display the damage degree of which. The camera (Canon 500D) was set in front of the detection window 80 cm, and the central of camera lens was parallel with the LED lights. Photographs of samples were obtained from the system.

3. Results and Discussion

3.1 Sewing Damage Situation of Untreated Cuprammonium Fabric

The sewing damage situation (figure 1) of untreated samples were tested by the designed testing device. Figure 1a was the photograph of unstitched fabric on which the transmission of the light traveling through was uniform. Which was also marked as the standard sample, and the other samples would be compared with. Figures 1b-1d were the transmission of samples which were sewed with stitch length of 1.0 mm, 2.0 mm, and 3.0 mm, respectively. It showed that the sewing damage tended to become smaller while the stitch length increased, the damages were serious when the fabric was sewed at stitch length of 1.0 mm compared with the standard sample.

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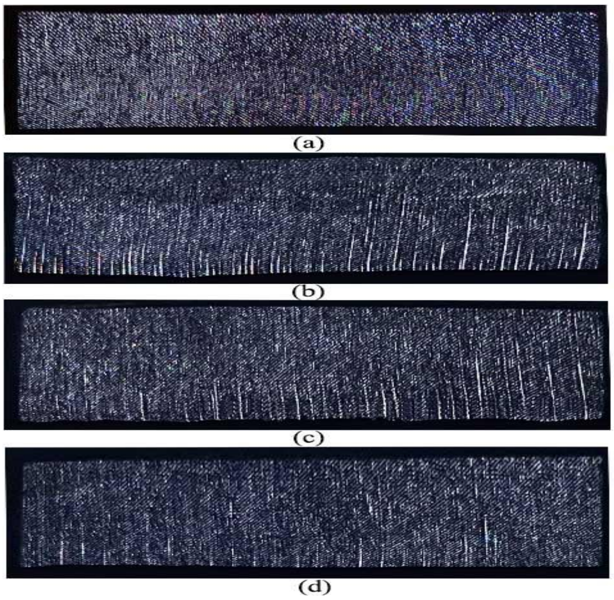

Figure 1. Damage of untreated cuprammonium fabrics. a. was the photograph of unstitched fabric which named as the standard sample. (b), (c), and (d) were the transmission of samples which were sewed with stitch length of 1.0 mm, 2.0 mm, and 3.0 mm, respectively.

3.2 Improving Effect of Cuprammonium Fabric Sewed with Different Needle Stitch Length Treated by Fusible Interlining at Fixed Margin

After the pre-treated producer of the fixed width of double-sided fusible interlining ironed between two layers of cuprammonium fabric, then the seam margin was fixed (0.5 mm). The construction formed by three layers were sewed with different needle stitch lengths of 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, and 3.0 mm. The damage situations were shown in figures 2b-2f, respectively. Compared with the standard A00 (figure 2a), the sewing damages were observed clearly in figures 2b-2c, but the damage degree was slighter than that shown in figures 2b-2c, sewed in the same needle stitch length of 1.0 mm and 1.5 mm, respectively. Damages were hard to observed in figures 2d-2f. That means if the needle stitch length of sewing is larger than 2.0 mm, the sewing damage were disappeared on this three-layer construction.

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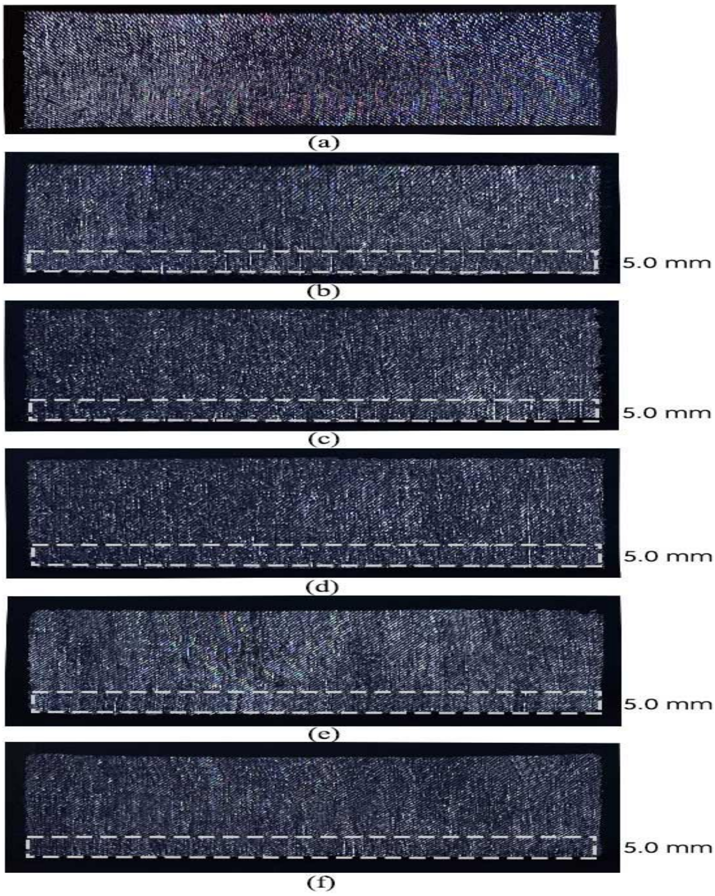

Figure 2. Samples with different stitch lengths with pre-treated of 5.0 mm seam margin of double-sided fusible interlining. The position of the fusible interlining was indicated by the blue dotted frame. (a) was the standard sample; (b,) (c), (d), (e), and (f), were samples sewed with needle stitch length of 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, and 3.0 mm, respectively.

3.3 The Improving Effect of Different Pretreated Seam Margin Sewed with Fixed Stitch Length

In this group samples the needle stitch length was fixed as 2.0 mm, and the seam margins (ironed with the fusible interlining) were set as 3 mm, 5 mm, 10 mm, 15 mm, and 20 mm, respectively. corresponding with figures 3b-3f. Compared with the standard A00 (figure 3a), the sewing damages gradually decreased as the width of seam margin increased. The sample C05 showed in figure 3c had little damage and smooth surface. For the sample C10 and C15 (figures 3d-3e) were almost hard to find larger arear of light transmissivity from the photography. On the other hand, the sample C20 (figure 3f), showed a certain degree of yarn deformation. This may be due to the width of the fusible interlining is too large while the fabric itself is relatively thin, thus, the fabric yarns had shifted during the ironing process.

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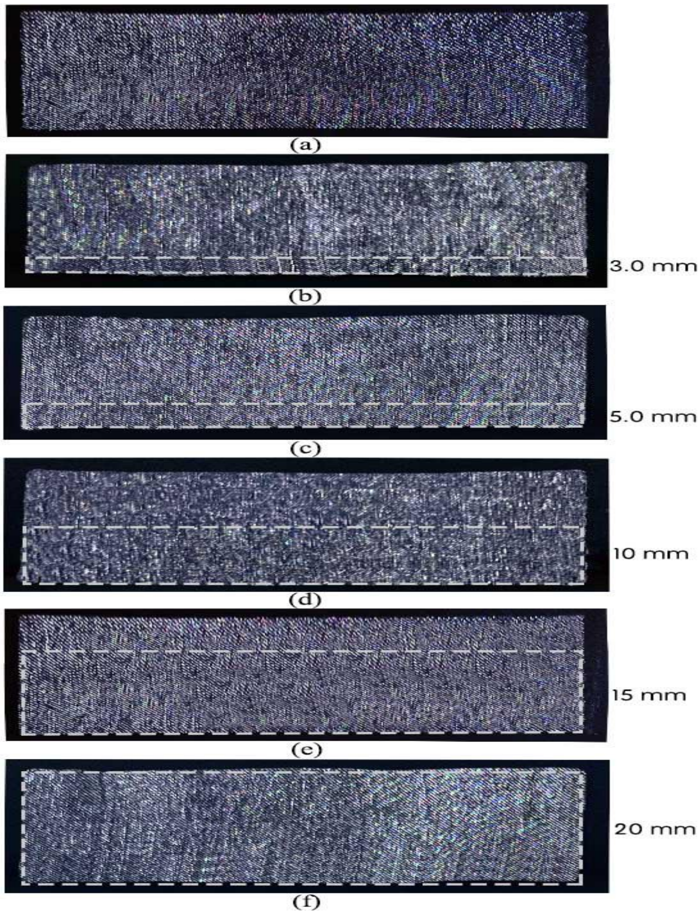

Figure 3. Samples pretreated with different interlining margins sewed with needle stitch length of 2.0 mm. The position of the fusible interlining is indicated by a blue dotted frame. (a) was the standard sample. samples shown in (b), (c), (d), (e), (f) were ironed interlining with seam margin of 3 mm, 5 mm, 10 mm, 15 mm, and 20 mm, respectively.

3.4 Mechanism of Sewing Damage Improvement

The photography of the three groups of different samples treated with different procedures demonstrated the sewing damage of pretreated cuprammonium fabric were significantly improved compared with the untreated ones. The damage situation of untreated samples was more serious and denser which was sewed with smaller needle stitch length.

The cuprammonium fabric is light and soft, which is woven from smoothy fiber filaments. When the fabric is stitched, the needle of the sewing machine has a force (FNP) worked on the surface of the fabric. A single yarn of the fabric may encounter or avoid the needle tip puncture during the stitching process. When the yarn avoids the needle tip puncture, there will not be any sewing damage. When a single yarn is pierced by the needle tip, the yarn receives two direction forces. One direction force is from the needle, and another is the integration friction force (∑f) provided by the other nearby yarns or fabric structure. If ∑f is smaller than FNP (equation (1)), conceptually, the single yarn in the fabric is twitched, as shown by the dotted line. when the fabric is sewed, the stitching damage could be obviously identified on the fabric surface. The smaller stitch length, the more yarns will be pierced, so the damage is more serious, which is consistent with the results.

$$\sum \mathrm{f} < F_{NP} \tag{1}$$

$$\sum \mathrm{f} \geq F_{NP} \tag{2}$$

The pretreated procedure enforced the value of dynamic friction, which made it possibly larger than F caused by needle tip. Which might cause the ∑f is larger than or equal the FNP (equation (2)), the single fabric would be in a stable state, and might not be moved. That’s the reason of

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enhancing the dynamic friction of a single yarn of the fabric through ironing the fusible interlining has a significant effect on improving the sewing damage.

4. Conclusion

To prevent the sewing damage of cuprammonium fabric, a group of sewing experiments were carried out on the untreated fabric to illustrate the damage situation which sewed by different stitch lengths. A facility was designed and built for identifying the state after the fabric sewed. Then, two groups of pretreated fabric were sewed to observe the damage, of which changed the stitch length or the seam margin of the fusible interlining to test the damage improving performances [9,10]. The results showed that as the width of the fusible interlining increases, the damage of the fabric gradually decreases. And the shorter the stitch length, the more obvious the sewing damage occur. And then, the mechanism of sewing damage improvement of a single yarn was analyzed. According to enhance method of the $\sum f$ by sewing technology can reduce the sewing damage of the cuprammonium fabric significantly. The results showed that using the fusible interlining to improve the sewing damage is effective. These methods worked on cuprammonium fabric might make this kind of fabric can be a good candidate material to manufacture garments.

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