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Changes in Dimensional stability and Total Appearance Value (TAV) of Wool-blended Fused Fabrics after Pressing and/ or Dry Cleaning

Ju-Won Jee

Dept. of Apparel Coordination, Jeonju Kijeon Women's College

모 접착포의 프레싱 처리와 드라이크리닝 처리에 의한 형태안정성과 의복형성능의 변화

지 주 원

전주기전여자대학 의상코디네이션과

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Abstract

본 연구에서는 실제 의복 관리와 생산 면에서 접할 수 있는 모 직물의 접착심과의 접착 후, 프레싱 처리 후, 드라이클리닝 및 프레스로 처리 후 직물의 형태안정성과 의복형성능의 변화를 살펴보았다. 겉감으로는 신사복 춘하용 모 100% 또는 모 혼방 직물 15종류를 사용하였으며 심지로는 신사복에 많이 쓰이는 3종류 심지를 사용하였다. FAST시스템과 KES시스템을 이용하여 직물의 접착 후, 프레싱 처리 후, 드라이크리닝과 프레싱 처리 후의 형태안정성과 의복형성능의 변화를 시험하였으며 다음과 같은 결과를 얻었다.

1) 모직물의 형태안정성에서 주요인자인 습윤팽창(HE)은 접착으로 크게 감소하였고 프레싱 처리와 드라이크리닝과 프레싱 처리 후는 접착 후보다 큰 변화를 보이지 않는다. 모직물의 습윤팽창(HE)의 조절시 접착심이 습윤팽창(HE)의 안정성에서 중요한 역할을 하는 것으로 나타났다.

2) 완화수축(RS)은 접착 후 조금 감소하였으나 큰 변화를 보이지 않고 프레싱 처리 후 현저한 감소를 보인다. 드라이크리닝과 프레싱 처리 후는 직물이 수축하고 볼륨감이 생김으로 완화수축(RS)은 더욱 감소하였다. 모직물의 완화수축(RS)의 조절시 프레싱이 중요한 역할을 하는 것으로 나타났다.

3) 모직물의 의복형성능(TAV)은 접착으로 크게 향상되었다. 드라이크리닝과 프레싱 처리 후 직물이 좀더 부드러워지고 볼륨감이 생기면서 의복형성능(TAV)은 적게 향상됨을 보인다. 이와 같이 3가지 처리는 서로 보완되어 모직물의 형태안정성과 의복형성능을 향상시키는 것으로 나타났다.

Key words: wool blended fused fabric, pressing, dry cleaning, dimensional stability, total appearance value(TAV); 모접착포, 프레싱, 드라이크리닝, 형태안정성, 의복형성능

I. Introduction

It is important in the finishing process to consider the mechanical properties of fabrics in order to obtain the good quality fabrics which satisfy the demands such as make-up properties or easy tailoring of garments(Matsui, 1986).

The mechanical properties of fabrics change as a result of different finishing processes. So, it is important for the finishing process to take into account the mechanical properties of fabrics. Therefore, it is necessary to survey the relationship between mechanical properties and the finishing process. In the previous paper, the changes in the mechanical properties, the primary hand value(HV) and the total hand value(THV) of fabrics after the finishing processes were reported(Jee and Lee, 2001). In this paper, the changes in dimensional stability and the total appearance value(TAV) of fabrics by different finishing processes will be reported. These two properties of fabrics were chosen for the practical purpose. The investigated finishing process of fabrics consists of three parts: fusing, steam pressing, and steam pressing after dry cleaning.

The dimensional stability of textile fabrics has always been a problem for both textile manufacturers and garment makers. Dimensional instability in a fabric can cause a variety of difficulties. 1) discrepancy from the intended garment size 2) seam puckering which cannot be pressed out 3) poor matching of components at the seams. The dimensional stability of wool cloth, besides being affected by the cloth construction, depends on the finishing treatments. There are three sources of dimensional instability in woven fabrics. Hygral expansion, is a reversible dimensional change which occurs when the moisture regain of a fabric is altered at a constant temperature. Thermal expansion, is a reversible dimensional change which occurs when the temperature regain of a fabric is altered at constant moisture level. Relaxation shrinkage, is a irreversible shrinkage caused by the release of cohesive or temporary set strains imposed during the stages of fabric finishing. These three sources of instability may be used to explain all the dimensional changes occurring in woven wool fabrics during finishing and garment making (Shaw, 1987).

Many workers have studied the dimensional stability of woven wool fabric. Cednas (1961) reported that shrinkage of lightly scoured wool cloth is caused by the moisture content of the fiber, but a change in moisture content can cause shrinkage which may be more or less permanent. Rhodes(1970) reported the shrinkage profiles of seven fabrics encountered in commercial fabrics used in dry-cleanable styles. It can be concluded that; (1) Shrinkage on drycleaning is cumulative. (2) Steam pressing increases shrinkage in woolen fabrics.

Good tailorability is the most important requirement for wool suiting fabrics. It is determined largely by the mechanical properties of the fabric and its dimensional stability. Important mechanical properties are bending rigidity and extensibility at low loads and these form the basis of expressions for fabric tailorability. Fundamental investigations have been made by Lindberg(1960), Shishoo (1990), Taylor(1984) and Niwa and Kawabata(1983). Niwa and Kawabata studied the relationship between the basic mechanical properties of fabric and the appearance of a suit by means of discriminant analysis. The judgement of appearance had five ratings similar to the total hand value of fabric handle. The experts named this rating 'Total appearance value' or 'TAV'. They deduced the appearance prediction equation as followed(Niwa and Kawabata, 1983).

$$TAV = Co + \sum (C_1 i Zi + C_2 i Z^2) \quad \cdots\cdots (1)$$

where, $$Zi = Co + \sum (aij + bij + Xij^2) \quad \cdots\cdots (2)$$

Co: constant,

$C_1 i$, $C_2 i$, aij, bij: Coefficient (i=1,2,3, j=1....m)

This equation (1), (2) experssed by following equation (3)–(6).

$$Z_1 = 1.660 + 1.855 \log EL_2 - 3.838 \log BS_2 - 0.805 \log SS + 0.310 \log EL_2^2 - 4.405 \log BS_2^2 - 2.260 \log SS_2^2 \quad \cdots\cdots (3)$$

$$Z_2 = 1.671 - 1.349 \log BP + 3.594 \log SP - 5.435 (\log BP)^2 - 1.249 (\log SP)^2 \quad \cdots\cdots (4)$$

$$Z_3 = -24.379 + 21.064 \sqrt[3]{BS/W} + 2.497 \sqrt[3]{SS/W} - 4.361 (\sqrt[3]{BS/W})^2 - 0.381 (\sqrt[3]{SS/W})^2 \quad \cdots\cdots (5)$$

where, Z_1 : formability component

Z_2 : elastic potential component

Z_3 : drape component

$EL = EM/LT$ $LT = 2WT/EMF_M$ ($F_M = 500$ gf)

$BS = B + HB$ $BP = B/2 \cdot (2.5 - HB/B)^2$

$S = G + HG_5$ $SP = G/2 \cdot (8 - HG_5/G)^2$

$$TAV = 1.122 - 0.470 Z_1 + 0.134 Z_1^2 - 0.034 Z_2 + 0.166 Z_2^2 + 0.345 Z_3 + 0.019 Z_3^2 \quad \cdots\cdots (6)$$

There are many reports concerning the dimensional stability and tailorability of fabrics by different finishing processes. Allan and Max(1985) observed that the traditional and highly desired electric press finish was shown to be characterized by a smoother handle, lower thickness and stiffness and higher formability. Ly et al.

(1988) reported the problems associated with fabric instability during tailoring and their relationship to the final garment appearance.

But there are few papers that have reported the changes in the dimensional stability and the total appearance value(TAV) of fabrics by the sequence of these finishing processes. Therefore, it is necessary to investigate the changes in the dimensional stability and the total appearance value(TAV) of fabrics resulting from different finishing process by measuring the dimensional stability and the total appearance value(TAV) of fabrics at each stage.

The purpose of this study is to investigate the changes in the dimensional stability and tailorability of fabrics after these different finishing processes have been applied.

II. Experimental

1. Test materials

Fifteen types of wool blended fabrics for spring/summer men's suits and three types of fusible interlinings were used for this study. Characteristics of the test materials used in this study are given in Tables 1 and 2.

2. Finishing Process

Test materials were subjected to the three stage finishing process. The fusing condition for fifteen fused fabrics were recommended by the interlining manufacturer. The appropriate interlining for the face fabric was chosen by the best results from the peel strength test and the shrinkage test. The finishing conditions which were recommended by the interlining manufacturer's manual are described in Table 3. The investigated finishing process of fabrics consisted of three parts: 1. fusing, 2. steam pressing, 3. steam pressing after dry cleaning.

3. Measurement of Mechanical property

All of the materials were conditioned at 20±2°C and 65±5% R.H. before testing.

1) The dimensional stability

Before and after finishing, the HE(Hygral Expansion) and RS(Relaxation Shrinkage) of the fabrics were measured using FAST(Fabric Assurance by Simple Testing) system(CSIRO, 1989).

Table 1. Characteristics of wool fabrics

No.	fiber contents (%)	yarn no. (Nm)		fabric density (ends*picks/cm^2)	thickness (mm)	wt. (g/m^2)
		warp	weft			
F1	wool/silk=82/18	2/140, 2/90	2/90	36*35	0.455	16.71
F2	wool/silk=60/40	2/72	2/140	22*32	0.538	18.72
F3	wool 100	1/30	1/30	25*24	0.577	18.89
F4	wool/linen=88/12	1/24, 2/72	2/72	20*21	0.539	21.47
F5	wool/silk=82/18	2/72	1/36	24*24	0.455	16.71
F6	wool 100	2/70, 2/72	2/70, 2/72	27*25	0.538	18.72
F7	wool/PET=95/5	1/30, 1/49	1/30, 2/72	28*27	0.577	18.89
F8	wool/PET=96/4	2/72, 2/160	2/72	22*23	0.539	21.47
F9	wool/PET=96/4	1/42, 2/72	2/72	22*23	0.455	16.71
F10	wool/PET=96/4	2/72, 2/72	1/42, 2/72	22*23	0.538	18.72
F11	wool 100	1/30	1/30, 2/72	25*26	0.577	18.89
F12	wool/silk=82/18	2/72, 2/60	2/72, 2/60	27*25	0.539	21.47
F13	wool 100	2/90	2/90	33*35	0.455	16.71
F14	wool 100	2/90	2/90	36*35	0.538	18.72
F15	wool 100	2/60	2/60	22*21	0.577	18.89

Table 2. Characteristics of interlinings

NO.	fiber contents (%)	weave	fabric density (ends*picks/cm^2) (yarn no: Nm)	adhesive	no. of adhesive dots/cm^2	adhesive wt. (g/m^2)	interlining wt. (g/m^2)	interlining thickness (mm)
I1	cotton 100	plain	17*11 (2/40, 2/40)	Polyamide	2.6	11	7.452	0.767
I2	cotton 100	broken-twill	18*15 (2/40, 2/40)	Polyamide	2.6	11	7.739	0.744
I3	cotton 100	plain	21*17 (2/40, 2/40)	Polyamide	2.6	11	7.661	0.629

Table 3. Finishing condition

Step	Process	Parameters
1	Fusing (roller press fusing machine)	temp. 120–140°C pressure 4kgf/cm^2 time 12sec
2	Steam Pressing	steam 5sec. pressing 5sec. vacumm 5sec.
3	Dry-cleaning	solvent: perchloro-ethylene cleaning temp. 30°C cleaning time 8 min.
	Steam Pressing	steam 2sec. pressing 2sec. vacumm 2sec.

2) Total appearance value(TAV)

Before and after finishing, the tensile, bending, shearing, surface and compressional properties of the fabrics were measured using the KES-FB system. And the total appearance value(TAV) was calculated by the equation on the basis of the previous measured mechanical data(Jee and Lee, 2001).

III. Results and Discussion

1. Dimensional Stability

Firstly, there was a remarkable change in the dimension after finishing. The previous paper(Jee and Lee, 2001) reported that the T(thickness) and W(weight) of fabrics increased after fusing, as expected. After pressing of the fused fabrics the T decreased and the W of fused fabrics increased. The steaming resulted in relaxing the fabric internal stresses and caused fabric shrinkage. After pressing followed by dry cleaning, the T and W of fabrics increased. This means that the action of mechanical force and dry cleaning solvents during dry cleaning made the fabrics shrink and bulky. These changes in dimension would influence the mechanical properties of the fabrics.

Steam pressing is a critical step in garment manufacture. Pressing has an important effect on length extention during finishing. In this process, the garments are moulded to their intended shapes and wrinkles are removed. Steam is also used extensively in garment after-care processes such as dry cleaning and laundering. The dimensional changes in pressing were largely reflected in the relaxation shrinkage and hygral expansion properties of fabrics(Allan et al, 1985; Le et al, 1993).

Dry cleaning is a gentle process that has become established as a way of cleaning textiles, especially clothing without any of the defects that can be caused by wetting with water and by washing. In considering shrinkage in drycleaning, then, it is necessary to recognize two aspects: (1) Shrinkage in the actual drycleaning process. (2) Shrinkage in the finishing; i.e., pressing (Rhodes, 1970).

1) HE(Hygral Expansion)

Hygral expansion is the change in fabric dimensions which occurs as the fibres absorb or lose moisture. This happens with environmental changes in humidity to fabrics made from fibres such as wool which have a relatively high regain.

Temperature and moisture have been very important factors in the viscoelastic properties of wool fibers. These effects can be represented by two mechanisms. First, changing temperature or moisture causes expansion or contraction in the volume of the fiber if it is not constrained, or otherwise causes additional stresses in the fiber itself. Second, this characteristic functions such as stress relaxation moduli and creep compliances vary with changing temperature and moisture content. The mechanical anisotropy of keratin related to the different mechanical properties of the two constituent phases in the composite structure are : the partially crystalline and partially water penetrate filament phase and amorphous, water penetrate matrix phase(Xiaoming and Postle, 1989).

The changes of warpwise and weft wise hygral expansion after finishing are shown in Fig. 1 and 2. After fusing, the warpwise hygral expansion(HE1) and weft wise hygral expansion (HE2) of the fabrics decrease, the range of HE1 was 0.5~4% and HE2 was 1~5%. The values of HE1 and HE2 of used fabrics were 1~4%, 1~7%, respectively. It is assumed that the constraint of fused interlining causes the stabilization of the fabrics. Especially, weftwise hygral expansion are stabilized by fusing.

It has been said that the disadvantages of hygral expansion can be serious in fabrics whose HE values are high-in excess of 5% linear. However, moderate hygral expansion is of great advantage and its possession by wool fabrics is one of the reason why wool has the justified reputation for producing tailored garments of superior appearance. The reason is that hygral expan-

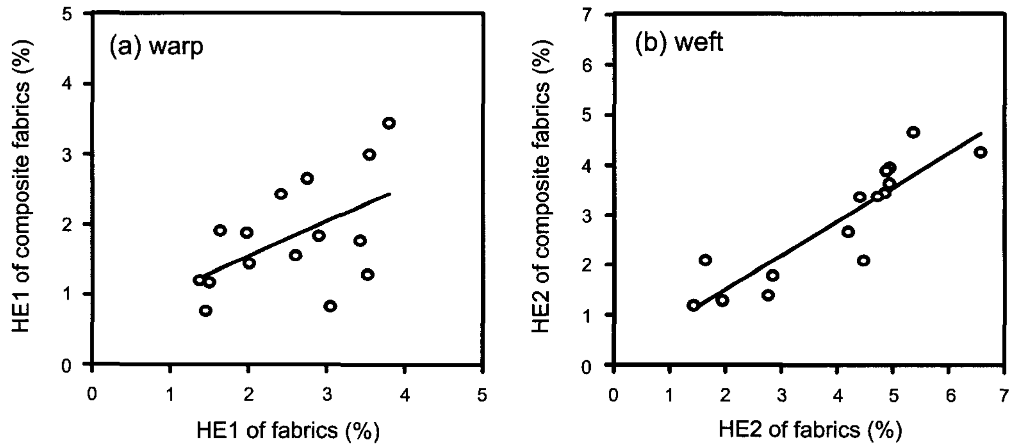

Fig. 1. Changes of HE of wool fabrics after fusing.

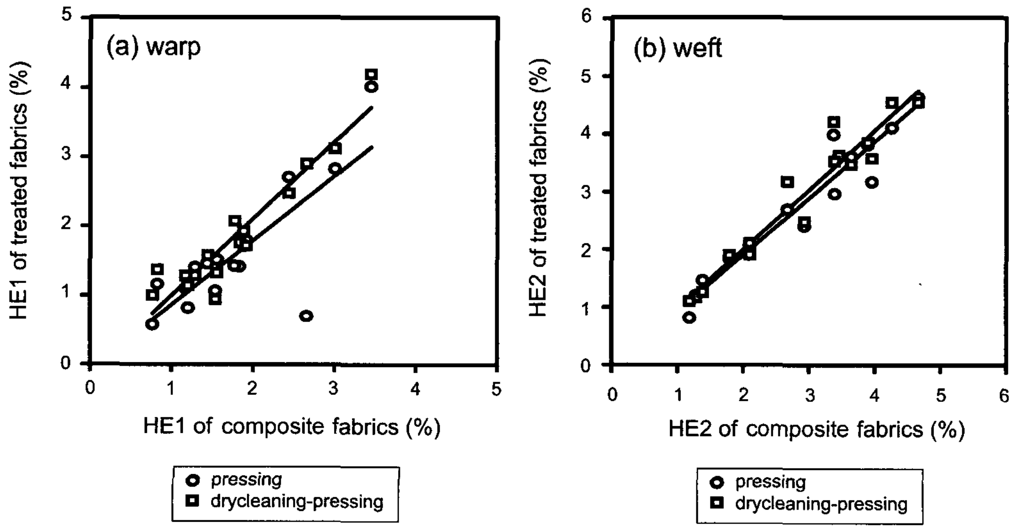

Fig. 2. Changes of HE of composite fabrics after treatment.

sion in a fabric allows fullness to be shrunk away where necessary-at sleeve heads, for example, and this assists in the creation of three-dimensional garment from a flat fabric (Shaw-part2, 1987).

After fusing the range showed better results. It may mean that the fusing process stabilizes the HEs of fabrics. The extent of hygral expansion is determined by the fabric structure as well as the finishing. When a fabric is initially woven the yarns can be in close contact with each other and the resulting inter-yarn friction produces a very stiff fabric. During the finishing process the yarns swell and are set with a higher crimp. When the fabric is subsequently dried the crimp remains and the inter-yarn friction is reduced, producing a fabric with lower shear rigidity(Roczniok et al, 1988). Also, it will influence the increase of TAVs of fabrics.

After pressing and pressing followed by dry cleaning, the changes in values of HEs was not so much. This result shows that the presence of interlining significantly increases the dimensional stability of the fabric after dry-cleaning. The properties of each piece of interlining is important to make a stable shape of the suit. If the fused fabrics are dimensionally unstable, the appearance of the suit becomes apparently defective. Shrinkage tests for

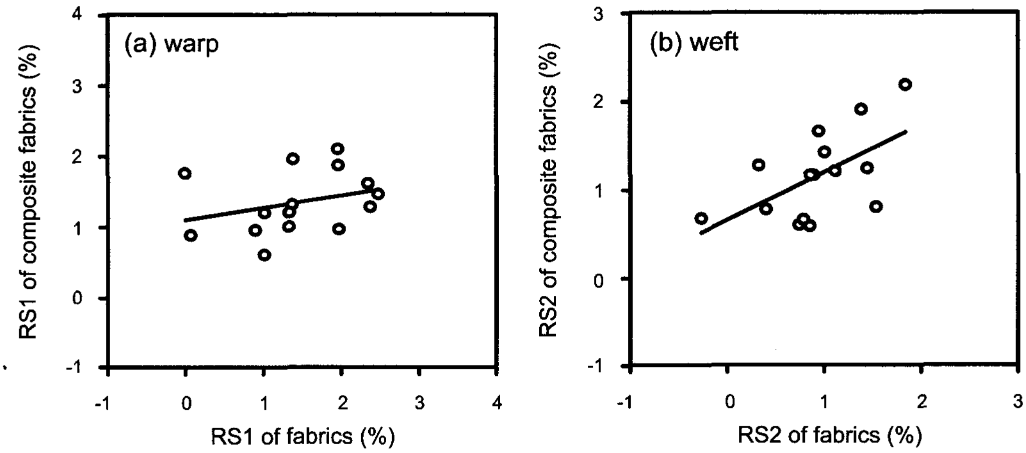

Fig. 3. Changes of RS of wool fabrics after fusing.

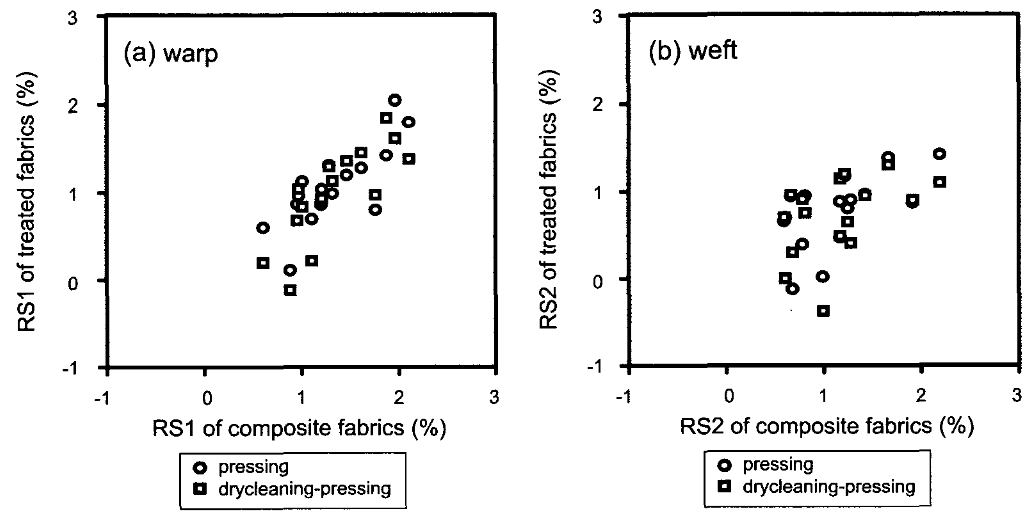

Fig. 4. Changes of RS of composite fabrics after treatment.

interlining materials should be done prior to other tests.

From the above investigation, it can be seen that fusing is an effective finishing process on the HEs of fabrics.

2) RS(Relaxation Shrinkage)

The changes of warpwise and weftwise relaxation shrinkage after finishing are shown in Fig. 3 and 4. After fusing, particular tendencies of the warpwise relaxation shrinkage(RS1) and weftwise relaxation shrinkage(RS2) of the fabrics were not shown. Until recently, no satisfactory explanation was available for the fact that wool fabrics shrink in the fusing press, but it had been observed that fabrics with high levels of hygral expansion tend also to have high levels of fusing-pressing shrinkage. Fabrics already shrunk by passage through a fusing press show a reduction in shrinkage during subsequent Hoffman pressing. So, it appeared that Hoffman pressing shrinkage, fusing pressing shrinkage, and hygral expansion were in some way related(Shaw-part1, 1987).

After pressing the values of RS1 and RS2 of the fabrics decreased greatly. The ranges of RS1 and RS2 of fabrics were 0.1~2%, -0.1~1.5% respectively. Textiles are subject to hygral change. It is often found that an area shrinkage of up to 4%, with a maximum 2.5% in length, can be tolerated in many garments, but complaints increased as shrinkage exceeds this figure.

Once the fabric has been fully relaxed no relaxation shrinkage can occur. A change in conditions cannot reintroduce the strains which have been removed. This is in marked contrast to the reversible swelling of yarn caused by the fibres absorbing moisture. Relaxation shrinkage can be minimized by appropriate finishing routines or wetting out and drying under minimal tension, e.g. sponging, before making up. Experienced tailors usually consider a relaxation shrinkage of 1 to 2% in length is advantageous for the ease of such operations as shrinking the sleeve head into the armhole seam (Roczniok et al, 1988).

After pressing followed by dry cleaning, the values of RS1 and RS2 of the fabrics decreased a little compared to those of pressed fabrics. The ranges of RS1 and RS2 of the fabrics after finishing were around 2%. It is the non-control zone shown in the FAST chart, so the results showed better quality in the sewing process. It meaned that the shrinkage was reduced by the sequence of finishing processes. It is mainly due to the pressing shrinkage. It shows that pressing mainly affected the relaxation shrinkage properties of the fabrics. The steaming operation aims at relaxing the fabric internal stresses, in order to reduce(even if it is not completely eliminated) the first cause of dimensional instability, namely relaxation shrinkage. During the initial stages of pressing, a fabric is heated by condensation of steam. Hygral expansion would normally occur, but cannot because the fabric is mechanically constrained by the locked press. Further steaming then causes the fabric to be set at a size smaller than is compatible with its regain. Since hygral expansion is reversible, the cloth will now tend to shrink when it is cooled and conditioned(Shaw-part1, 1987).

The relaxation of strains in a textile fabric, leading to shrinkage, can take place to some extent in a well regulated drycleaning process. This is especially so in taking into account the whole operation, that is not only the treatment with solvents but also the finishing, usually steam pressing, that follows. Certain features of the drycleaning process can also influence the shrinkage of textiles. The solvent itself has no effect, provided that it does not swell the fibres and its temperature also has no effect except with heat sensitive fibres. (1) The mechanical effect caused by the rotation of the articles in the cage of the machine during drycleaning has a definite relaxing effect and aids shrinkage. (2) The water added to the solvent in cleaning tends to give quicker relaxation. (3) The drying temperature is important when heat sensitive fibres are being cleaned. (4) Steaming after drycleaning is a major cause of relaxation shrinkage (Rhodes, 1970).

After finishing, the RS1 and RS2 of some of the fabrics showed minus values. Through the finishing, the fabrics became compact and shrunk. So, if the stress was relaxed, the length of the fabrics might extend. It is a very interesting phenomena that the HEs of fabrics were stabilized by fusing whereas the RSs of fabrics were stabilized by pressing.

From the above investigation, it can also be seen that pressing is an effective setting process on the RSs of fabrics.

2. Total Appearnace Value(TAV)

Tailorability can be defined as the ease with which a fabric is made up into a high quality garment. Garment appearance is the most easily recognizable mark of quality. As the tailoring process involves steaming operations and exposure of different part of the garment to atmospheres of varying humidity, relaxation shrinkage and hygral expansion are of most concern to a tailor. Fabric dimensional stability together with other mechanical properties will affect a garment's appearance and perhaps more importantly its appearance retention during wear (Roczniok et al, 1988).

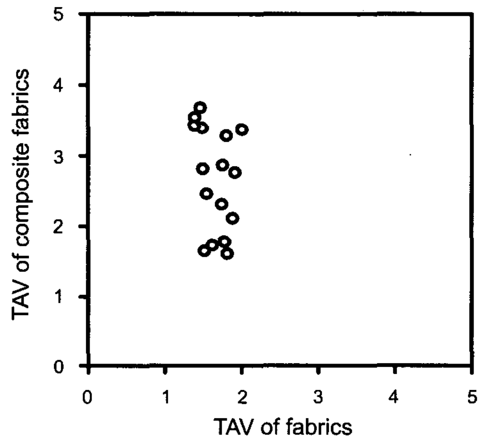

Fig. 5. Changes of TAV of wool fabrics after fusing.

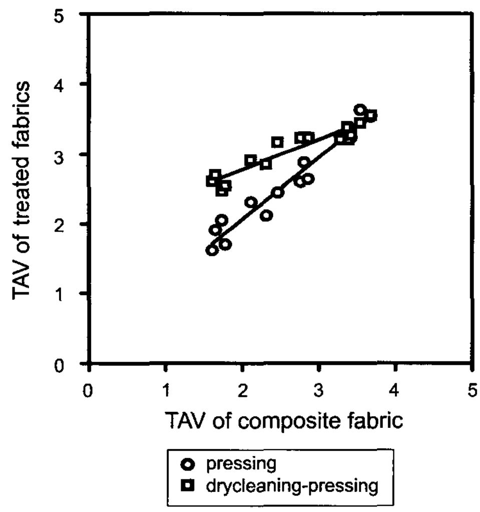

Fig. 6. Changes TAV of composite fabrics after treatment.

The changes of TAVs after finishing are shown in Fig. 5 and 6. After finishing, bending rigidity, bending hysteresis, shear rigidity and shear hysteresis increased, while the extensibility deceased by fusing and increased by other finishing processes, as reported in the previous paper(Jee and Lee, 2001). These changes in mechanical properties affect fabric quality. As a result, TAVs of fused fabrics increased. After fusing, the TAVs of fabrics increased greatly. It means that fused fabrics provide better quality on tailorability. After pressing, the TAVs of fabrics change was not so great compared to those of fused fabrics. After pressing followed by dry cleaning, however, the ranges of TAVs of fabrics were 2.5~4%. It was the best result of these finishing treatments. The fabrics became softer and more flexible than only pressed fabrics, due to the action of mechanical force and dry cleaning solvents. With respect to TAV, the fusing process plays a important role. The proper selection of fused interlinings for wool fabrics ensures a satisfactory quality.

From the above investigation, it can be seen that fusing is an effective finishing process on the TAVs of fabrics.

IV. Conclusion

In this paper, the changes in the dimensional stability and Total Appearnace Values(TAVs) of fabrics through different finishing processes were reported. The finishing process of fabrics consists of three parts: fusing, steam pressing, and dry cleaning. Fifteen types of wool blended fabrics for spring men's suits and three types of fusible interlinings were used for this study. Before and after treatment, the dimensional stability of fabrics were measured using the FAST system. And the TAVs were calculated using the equation on the basis of measured mechanical data.

The results obtained from this study were as follows.

1) After fusing, hygral expansion(HE) decreased by the constraint of fusible interlining. After pressing and pressing followed by dry cleaning, the values of the HEs for the fused fabrics were not significantly different before and after the finishing process. For the control of the HEs of the wool fabrics, fusing process

seemed to be more important than the other processes.

2) There was a little difference between the relaxtion shrinkage(RS) of fused fabrics and those of the wool fabrics only. However, the RSs of the fused fabrics deceased as a result of steam pressing. Steam pressing operated as relaxing the fabric internal stress and caused fabric shrinkage. After pressing followed by dry cleaning, the fused fabrics shrunk and became bulky, so the values of the RSs of the fabrics decreased more.

3) The tailorability of fused fabrics increased after fusing. The increase of the TAVs of fabrics may be caused by the increase of B and G after fusing, as observed in the previous paper. After pressing followed by dry cleaning, the fabric became soft and bulky, so the TAVs of fabrics increased a little.

4) These finishing processes lowered the dimensional instability and increased the TAVs of the fabrics.

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