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REPRODUCIBILITY OF KANSEI PROPERTY OF TEXTILE FABRIC
A CASE STUDY OF HIGH-END SILK FABRIC

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ABSTRACT

Reproducibility of *KANSEI* property for textile fabric was investigated by reverse engineering. Producer's *KANSEI* in manufacturing process was also considered. Silk woven fabric of luxury brand apparel was selected as an original sample and the specifications were inspected. Japanese manufacturers made an experimental fabric from raw silk to finishing processing according to the specifications observed the original fabric. The specifications of experimental fabric were inspected and those physical properties were measured. Those results were compared with the original fabric. Carrying out sensory evaluation test about fabric hand, the hand of both fabrics was investigated. In addition, we tried to find the reason of different handle with physical properties. Sensory evaluation test was carried out by paired comparison test for the original and experimental fabrics. As a result of sensory evaluation test, a grasping sense for both fabrics was almost the same but senses of surface roughness and stretchy were different. Even if the specifications were given to manufactures, it was difficult to manufacture a fabric with the same hand. Comparing experimental fabrics after dyeing process to experimental fabric before dyeing process, senses of grasp and stretchy were different. It may be conceivable that dyeing and finishing processes affected to the handle. The results of sensory test on fabric hand between the original and experimental fabric were different and the reason could be that fabric handle depended on manufacturer's discretion in the manufacturing process (manufacturer's *KANSEI*) which was not appeared in specifications such as applied tension of warp yarn in weaving and time for dyeing and finishing processes.

Keywords: *Apparel, Evaluation, Physical measurement, Sense measurement, Touch*

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1. INTRODUCTION

There are various apparel brands all over the world and the price and design are diversified. In Japan, overseas luxury brand clothes are being purchased by many people in spite of the high price. The design, pattern, sewing and textile material are considered as the values of luxury brand apparel. By revealing the values through the comprehensive evaluation of product based on design and wear comfort, it could be possible to manufacture a product in Japanese domestic apparel industry to overcome luxury brand products. In this research, silk fabric of overseas luxury brand apparel was selected as an original sample and the basic data was investigated.

The values for clothing material were assumed as following two points. 1) Fabrics of luxury brand apparel were used the designing and manufacturing technology which could not be imitated in Japanese domestic apparel industry. 2) Fabrics of luxury brand apparel had different physical properties caused by the technology. To study the assumption 1), silk fabric of overseas luxury brand was manufactured by reverse engineering in Japanese domestic company. To study the assumption 2), geometrical structure and physical properties of fabric by foreign manufacturing and those by Japanese manufacturing which were considered as being similar to the handle of original fabric were compared.

The following studies were investigated in previous study [1]. Firstly, we analyzed the design specifications of the original sample based on JIS L 1096 [2] and manufactured an experimental fabric based on the inspected data. In the process of manufacturing the experimental fabric, we asked some specialists of yarn twisting, weaving and dyeing and finishing factories in Japan about the present state of manufacture for Japanese silk fabric. We found the following facts by the result of hearing investigation to manufacturers. In Japanese silk industry, there are a few specialists who can carry out analysis and design for complicated fabric like double georgette. And it was also found that there are few specialists who can design and control entire manufacturing process for silk fabric from raw silk to dyeing and finishing processing presently in Japan. Secondly, the design specifications and physical properties of the experimental fabric were analyzed and those results were compared with those of the original sample. The weaves, weave density and twist shrinkage percentages of the experimental and original fabric were different from each other. Although the extensibility of warp direction was higher than that of weft direction in the original sample and the extensibility of weft direction was higher than that of warp direction for the experimental fabric. The reason, why it was unable to imitate the original sample at once in Japanese manufacturing process, was considered that the manufacturer's technique and *KANSEI* were different.

Moreover, the physical properties in tensile and compression properties of the experimental fabric and the experimental fabric without dyeing were different. The unknown value which would not be shown in design specifications could be come out during the dyeing and finishing processing. The weave and yarn twist was different and physical properties of Japanese similar fabric handle and overseas similar fabric handle were also different. Therefore, it was clear that the design specifications of woven fabric affected to physical properties of that.

In this research, we investigated the sensory impression of fabric of different fabric construction.

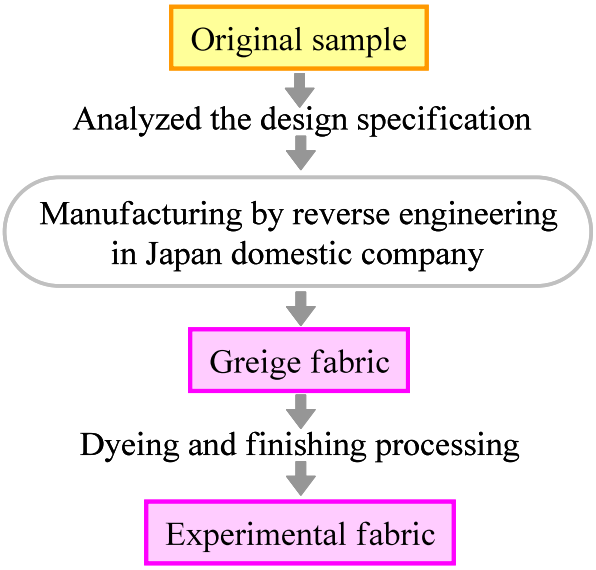


Figure 1: Process of making the experimental fabric and greige fabric.

2. EXPERIMENTAL

2.1. Method

The fabric hand was investigated by sensory evaluation test [3, 4].

In sensory evaluation test, 18 words, which were described the tactile impression, were selected and 5 styles of touching method were devised. Table 1 shows the method of movement and the question items about sensory evaluation test. Because the testing was carried out in Japanese, question items in Table 1 show Japanese. The impressions of fabrics were evaluated by paired comparison test of 7 stages under the environment except for the effect by a visual sense. 10 male and female of university students were participated in the sensory evaluation test as subjects. The test was carried out at standard atmospheric conditions room (20±2℃ temperature, 65±5% relative humidity). Scheffe's paired comparison method (Nakaya's modified method) was used for analysis for the results of sensory evaluation test.

Moreover, relativity between the results of sensory test and those of physical properties which were measured by using KES-FB system (KATO TECH CO., LTD) and HV (Hand Value) which was calculated measurement value from KES [5, 6] was investigated in this study.

2.2. Samples

5 samples (original sample, experimental fabric, greige fabric, overseas similar fabric and Japanese similar fabric) were prepared and the definition and details were shown in Table 2. Design specifications of samples were also shown in Table 3.

Table 1: Method of movement and question items

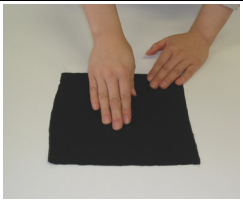
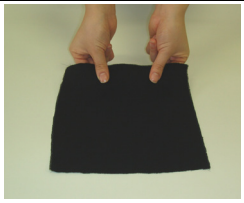
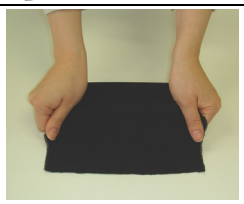
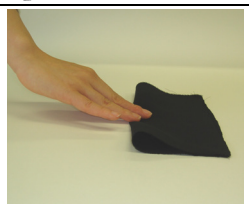
	Touching style A	**Touching style B**	**Touching style C**
Movement	Stroke right and left with straighten finger	Touch on both sides of a fabric with thumb, forefinger and second finger	Grasp with palm
Direction	warp and weft	-	-
Figure			
Question Items	1. smooth (NAMERAKADA)	1. smooth (NAMERAKADA)	1. bouncy (DANRYOKUGAARU)
	2. slippery (SUBERIYASUI)	2. slippery (SUBERIYASUI)	2. soft (YAWARAKAI)
	3. good tactile sense (TEZAWARIGAYOI)	3. thin (USUI)	3. fullness and softness (FUKURAMI)
	4. like (SUKI)	4. like (SUKI)	4. anti-drape stiffness (HARI)
	5. high quality (KOUKYUUKANNGAARU)	5. high quality (KOUKYUUKANNGAARU)	5. stiffness (KOSHI)
	Touching style D	**Touching style E**	
Movement	Strain in a transverse direction	Push the folded edge of a fabric	
Direction	warp and weft	warp and weft	
Figure			
Question Items	1. stretchy (NOBIYASUI)	1. bouncy (DANRYOKUGAARU)	
	2. good property of elastic recovery (NOBIMODORISEIGAYOI)	-	

Table 2: Samples

Samples Name	**Details**
original sample	Woven fabric of the suit made by A company (made in Italy, 100% silk)
experimental fabric	the fabric which was manufactured identically based on 'original sample' in Japan
greige fabric	the manufactured fabric without dyeing and finishing processing
overseas similar fabric	the fabric which the specifications and fabric hand were similar to 'original sample' made by overseas company (made in Italy, 100% silk)
Japanese similar fabric	the fabric which the specifications and fabric hand were similar to 'original sample' made by Japanese company (made in Japan, 100% silk)

Table 3: Design specifications of samples

Items		Original sample	Experimental fabric	Greige fabric	Overseas similar fabric	Japanese similar fabric
Fineness [D]	warp	63	78	80	72	72 (72*)
	weft	83.7	101.9	98	72	81
Weave density [/cm]	warp	159.2	139.6	147	135.3	182
	weft	72	68.8	72.4	75.3	60.7
Amount of twist [Turns/m]	warp	2800	2800	2900	2660	2720 (740*)
	weft	2400	2450	2470	2590	3020
Percentage of twist shrinkage [%]	warp	27.748	13.2	12.6	12.8	11.3 (0.4*)
	weft	17.68	11.5	10.8	7.1	15.2
Fabric weight [g/m^2]		236	232	246	204	183
Thickness [cm]		0.0503	0.0446	0.0469	0.041	0.0377

*stitch yarn

3. RESULT AND DISCUSSION

In touching style A, the results of 'original sample' and 'experimental fabric' were significantly different. However between 'experimental fabric' and 'greige fabric' did not show any difference (see Figure 2). A sense of fabric surface smooth was recognized by little difference of design specifications. The test results between MMD (Mean deviation of coefficient of friction) and the results of smooth sense showed some relationship except for 'Japanese similar fabric'. Dyeing and finishing process was unable to inspect so that it did not appear on the design specifications. From these result, it was expected that dyeing and finishing processing had effects on the surface handle.

In touching style B, the results of 'original sample' and 'experimental fabric' were evaluated as having a similar fabric hand. 'experimental fabric' and 'greige fabric' were evaluated as having a different fabric hand (see Figure 3). Even though the touching method of style A and B contained the same stoke movement, the test results were different. Comparing the test results of sensory test to WC (Compressional energy) of compression qualities, there was a linear relation in smooth sense item.

Moreover, 'Japanese similar fabric' was shown the highest values in items 'smooth', 'slippery', 'like' and 'high quality' which were the same items in touching style A and B, it was clear that the subjects felt the smooth sense of surface fabric as high quality (see Figure 4).

In touching style C, the results of the items for 'bouncy' and 'soft' were similar especially between 'original sample' and 'experimental fabric'. The results of others in touching style C were evaluated differently with 'original sample', 'experimental fabric' and 'greige fabric'. The results of touching style C were compared with HV because a grasping tactile sense was influenced by various physical properties. As shown in Figure 5 and 6, there was a linear relation between a fabric hand and 'KOSHI (a feeling related with bending stiffness)' and 'FUKURAMI (a feeling come from bulky, rich and well formed feeling)' of HV except for 'Japanese similar fabric'. This showed that the difference of the design specifications influenced to the physical properties, and it was able to feel the differences of a fabric hand depending on different grasping method.

In touching style D, 'original sample' was the stretchiest fabric in warp direction and 'Japanese similar fabric' was the stretchiest fabric in weft direction (see Figure 7 and 8). These results were almost agreed with the measured value of EMT (elongation of the tensile property) of tensile property. EMT is elongation at 500gf/cm load. From these results, it seemed that the percentage of twist shrinkage in design specifications had an effect on EMT (Figure 9). It was expected that selecting the thread was needed to consider the image of a garment after dyeing and finishing process. It will be able to make a fabric with suitable silhouette for garment in wear.

In touching style E, 'experimental fabric' was evaluated as bouncy in both warp and weft direction, and 'overseas similar fabric' was evaluated as not bouncy (see Figure 10). There were several relations between the results of touching style E and B (bending rigidity) of bending property or LC (linearity) of compressional property. However it will be needed to investigate the reason of several relations in the future.

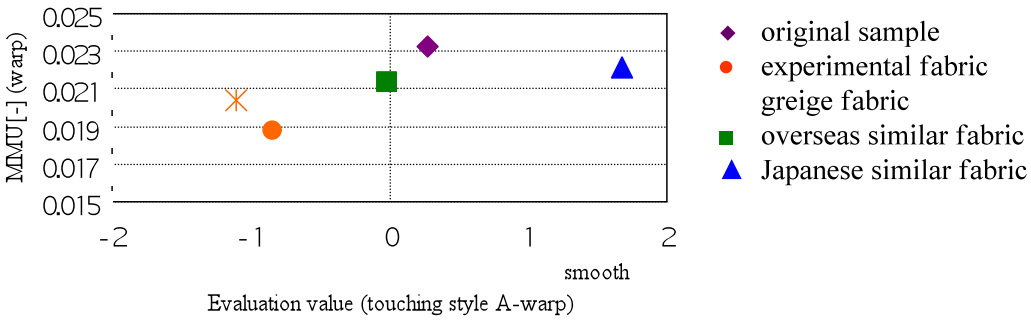


Figure 2: Relation between 'smooth' (touching style A-warp) of evaluation value and MMD (warp) of physical property

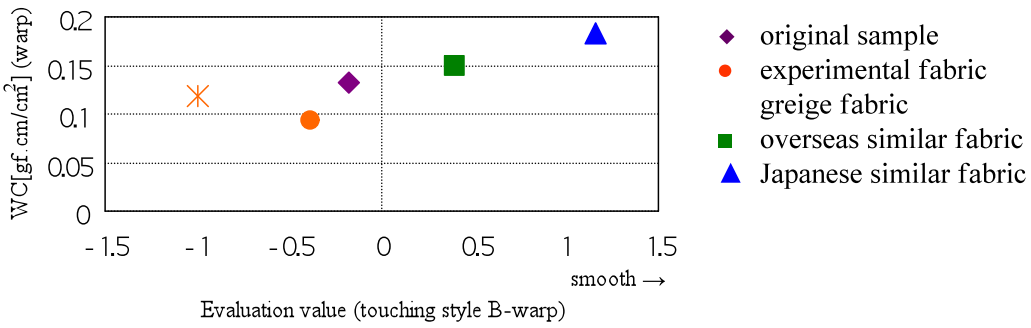


Figure 3: Relation between 'smooth' (touching style B-warp) of evaluation value and WC (warp) of physical property

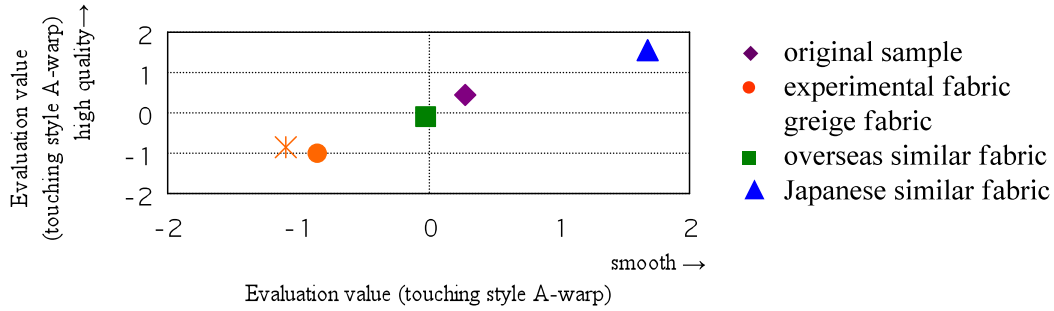


Figure 4: Relation between 'smooth' and 'high quality' (touching style A-warp) of evaluation value

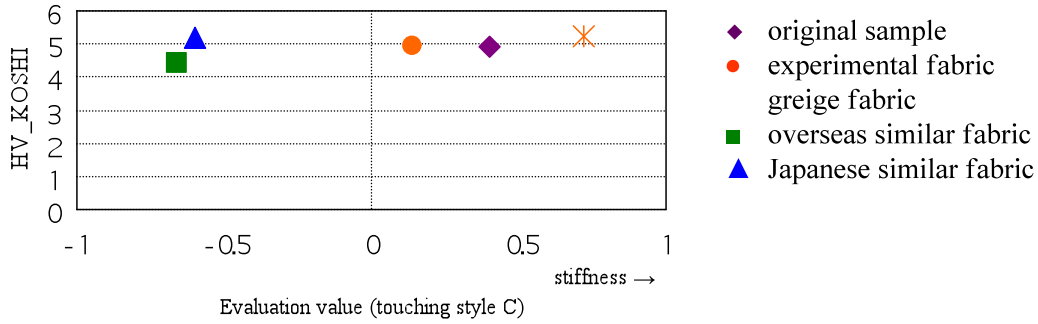


Figure 5: Relation between 'stiffness' (touching style C) of evaluation value and 'KOSHI' of HV

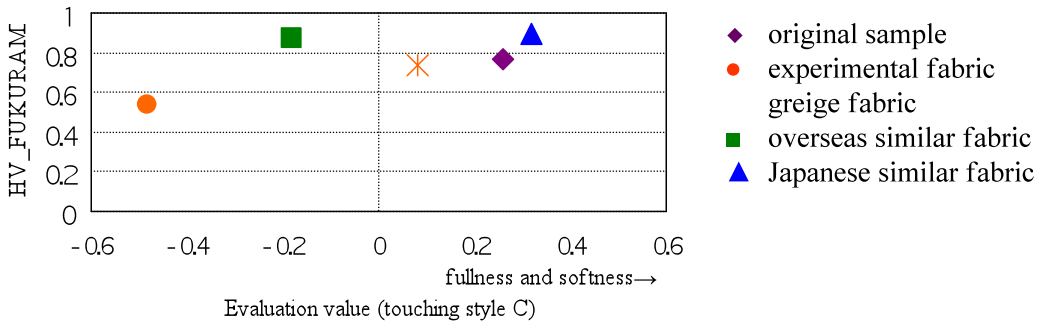


Figure 6: Relation between 'fullness and softness' (touching style C) of evaluation value and 'FUKURAMI' of HV

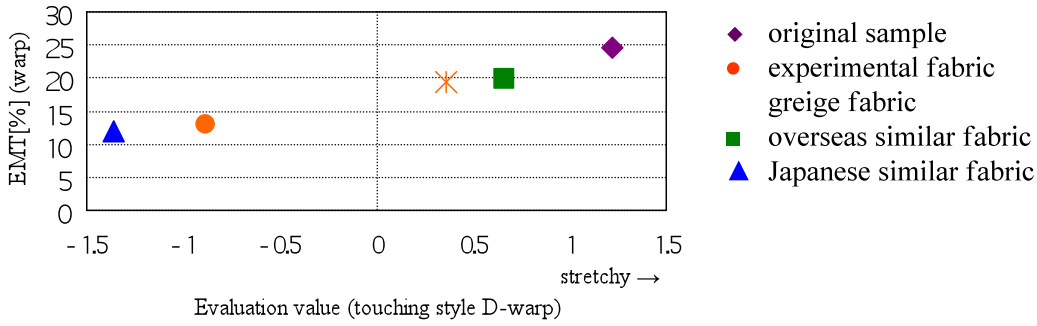


Figure 7: Relation between 'stretchy' (touching style D-warp) of evaluation value and EMT (warp) of physical property

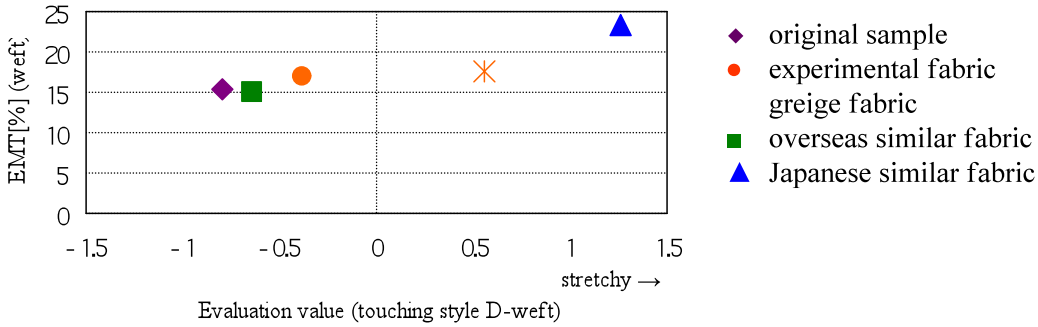


Figure 8: Relation between 'stretchy' (touching style D-weft) of evaluation value and EMT (weft) of physical property

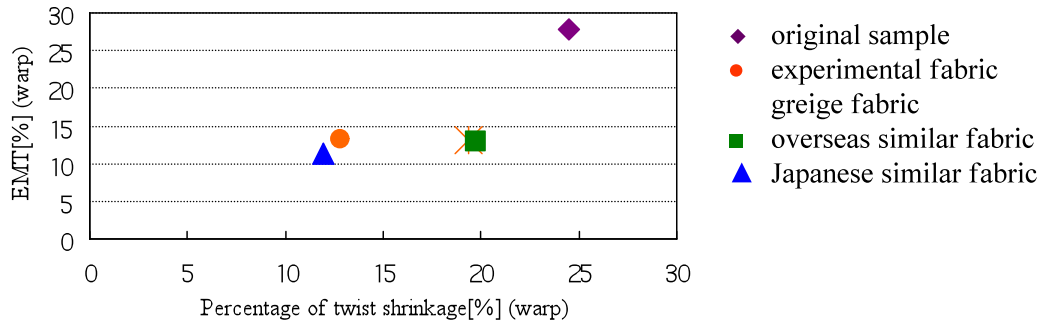


Figure 9: Relation between percentage of twist shrinkage (warp) of design specifications and EMT (weft) of physical property

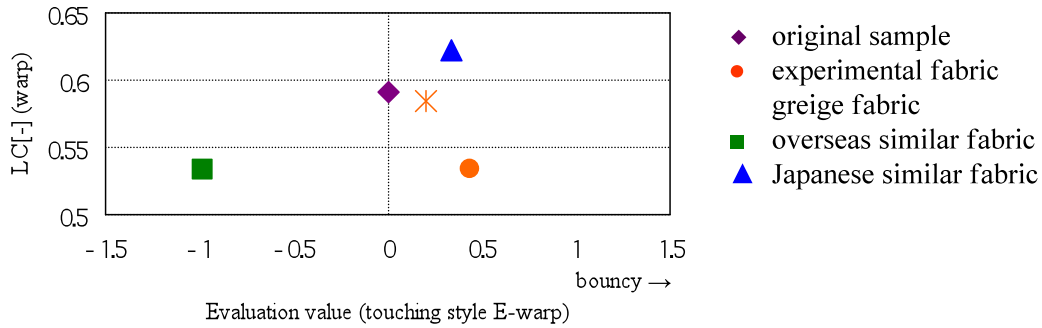


Figure 10: Relation between 'bouncy' (touching style E-weft) of evaluation value and LC (warp) of physical property

4. CONCLUSIONS

We compared 'original sample' which was silk woven fabric of luxury brand apparel to 'experimental fabric' which was manufactured identically based on 'original sample' in Japan. The results of sensory test for a touching and grasping sense for both fabrics were almost similar but the other senses were different. These results were influenced by little difference of the design specifications between 'original sample' and 'experimental fabric'. In addition, it was clear that design specifications which were obtained by fabric analysis could not be show the factors which affected to a fabric hand. In other words, 'original sample' had the different physical properties which could not be reproduced by the design specifications and those influenced on the difference of the fabric hand. Moreover, comparing 'experimental fabric' and 'greige fabric', the results of stroke right and left were shown similar results but the others were different. It may be conceivable that dyeing and finishing processing affected to the fabric hand.

Consequently, it was expected that the different manufacturing technique and methods which were not appeared on the specifications were caused these different results between 'original sample' and 'experimental fabric' [7, 8]. For example, we were found that speed of

yarn twisting, applied tension of warping, time taken for dyeing and method of finishing were the manufacturing parameters which affected to physical properties and hand for fabric. These parameters were controlled depending on the direction of manufacture in the manufacturing process and their *KANSEI*. Therefore, if the manufacturing parameters could be quantified, it would be possible to control physical properties and hand of silk fabric more accurately. In other words, by discovering and quantifying the parameters, it will be possible to manufacture 'experimental fabric' close to 'original sample'. Therefore, through these methods, it will be possible to manufacture the silk woven fabric with *KANSEI* which means fabric considered not only physical properties but also fabric hand of that.

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