Objective Evaluation of Baby's Underwear Materials for Comfort Clothing Life

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Abstract: This study aims to estimate the properties of baby's clothes materials and consider the applicability to Baby's underwear. Observing styles appeared in our daily clothing lives, the underwear which should be put on inside is important to form comfort clothing macroclimate under layers of clothing from the inside to the outside. Under wear materials are required to play roles as materials worn next to skin. The underwear requires the movable design, materials with tender touch feeling and good moisture transport from the previous study. Especially for baby's underwear materials, the fabrics must be selected carefully since the heat capacity of their body is small and the skin epidermis is thin. In this study typical materials worn next to skin are collected among cover-all wears on the market. Twenty kinds of samples are selected. Cotton and cotton blend fabrics are mainly used for the baby and lady's underwear. Samples are measured for their physical properties and the transfer properties of air, heat and water. From the results of low specific density value and compression property, underwear of pile fabrics is suitable in winter. Underwear of 1x1 interlock knitted fabrics can be napped easily and produced various fabrics adopted widely use. They are suitable in all seasons from the thermal and air permeation property, and shows smoothest and softest touch feeling among sample groups in this study.

Keywords: baby's underwear, comfort, physical property, air/water transport

1. INTRODUCTION

Baby clothes market is brisk in Asian countries regardless of a declining birthrate and aging population in the society. It is said that the age of baby-wears comes to a close in baby clothes business. Objective evaluation of baby clothes shall be demanded and the development of properties expected. In baby clothes, under-wears play the important roles, such as showing a pretty appearance and keeping appropriate environment around babies. In previous papers [3,5,6], studies on the objective evaluation of baby coverall wears has been carried out and reported that the flexibility of baby coverall wears can be described using tensile mechanical properties. In this study, considering the limber baby's body, the tensile, compression property and surface frictional is important to examine. And the objective evaluation of soft feeling is seriously expected to stand. After market research, we conduct a questionnaire on the recognition of baby clothes to consumers who shall be parents in future. The impression and expectations of baby's wears are asked. And then typical kinds of baby under-wear clothes are collected. Materials of them have be brought to the touch feeling sensory test. On the other hand, the experiment of the tensile, compression property and surface friction are carried out for the quantitative estimation. It is essential to progress the objective evaluation from different angles such as the questionnaire survey, the sensory test and the experiment.

2. QUESTIONNAIRE INVESTIGATION

In order to get the knowledge and requirements of consumers, questionnaire investigation was carried out as follows:

Term: October to December 2013

Subjects: 210 universities students, 20-22 years old

Investigation method: Using a questionnaire, Subjects fill out evaluation forms which include

Five items on motive for purchase, size, materials, value of self garment choice and general preference of baby clothes.

After collected questionnaire sheets, answers on items were amounted and discussed.

3. EXPERIMENTAL

3.1. Samples

After researching the baby clothes figures and materials, 22 typical baby's wears were prepared. Basic properties of samples for this study are shown in Table 1.

Group	no.	Structure	Fiber content	Weight	Thickness	Bulk density	stitch density	
				mg/㎠	mm	g/㎤	Wales/inch	Course/inch
s	1	1x1 interlock	cotton100%	14.49	1.012	0.143	32	45.5
	2	1x1 interlock	cotton100%	19.57	1.334	0.147	39.5	42
	3	1x1 interlock	cotton70/acrylic30%	19.25	1.753	0.110	387	28.5
	4	1x1 interlock	cotton100%	21.80	1.361	0.160	40.5	42.5
	5	1x1 interlock	cotton100%	15.18	1.080	0.141	31.5	50.5
	6	1x1 interlock	nylon100%	7.57	0.266	0.284	52	32
	7	1x1 interlock with napped	acrylic90/cotton10%	18.69	2.887	0.065	23.5	25.5
	8	quilt	cotton100% PE inside	19.56	2.095	0.093	33.5	37.5
	9	1x1 interlock with napped	cotton95/polyurethane5%	24.23	1.989	0.122	35	47
w	10	1x1 interlock	wool100%	24.04	1.118	0.215	39.5	36
f	1	1x1 rib	wool100%	26.49	1.495	0.177	52	43.5
g	1	woven double gauze	cotton100%	10.82	1.015	0.107	52	46.5
	2		cotton100%	12.16	0.861	0.141	61.5	48
p	1	plain knitted with pile	cotton100%	21.36	1.822	0.117	31	32
	2		cotton60/polyester40%	19.80	1.950	0.102	27	38.5
	3		cotton80/polyester20%	18.78	1.607	0.117	28.5	33.5
m	1	mesh knitted net	cotton100%	9.89	1.011	0.098	29	31.5
t	1	plain knitted	cotton100%	11.56	0.793	0.146	36	43
	2		cotton100%	11.68	0.707	0.165	38.5	43
	3		cotton100%	16.26	0.960	0.169	29.5	38.5
	4		cotton100%	15.36	1.041	0.148	38.5	48.5
	5		cotton100%	20.91	1.460	0.143	35.5	50.5

The samples were divided into six groups from knotting/weaving structures. The letter of group column shows the structure types (s;1x1 interlock and w from wool fibers belong to this group, f;1x1 rib, g; double gauze, p; plain knitted with piles, m; Knitted like mesh, t; plain knitted).

3.2. Measurement of structural properties and mechanical properties

Compression and surface properties were measured by KES-FB3 and FB4 testing apparatuses respectively. Thickness at the compression stress of 0,5gf/cm^2 was derived from the compression stress-thickness curve measured under the condition at the maximum compression stress of 50gf/cm^2. Mean coefficient of kinetic friction, MIU, and MMD, which indicates the deviation value of MIU are detected from the recorded wave of the frictional force- distant of samples surface. SMD shows the surface roughness that is the deviation of thickness.

3.3. Measurement of air resistance and water absorption

Air resistance was measured by KES-AP1 apparatus under one cycle process of the charge-discharge of constant air flow amount through sample sides.

Those experimental measurement were carried out in the laboratory controlled at the standard condition of 20$\pm$2 and 65$\pm$5%R.H.

For water absorption, rectangle of specimen were taken from samples of each group and conditioned in the high temperature box until no-water level of specimen, weighed as $w_{0.}$ And then the specimen were put in high humid chamber and weighed as w_x at regular intervals for more than 160hours. The changes of water absorption (=(w_x-w_0)/w_0 x100, %) were recorded.

4. SENSORY TEST BY TOUCH AND VISION

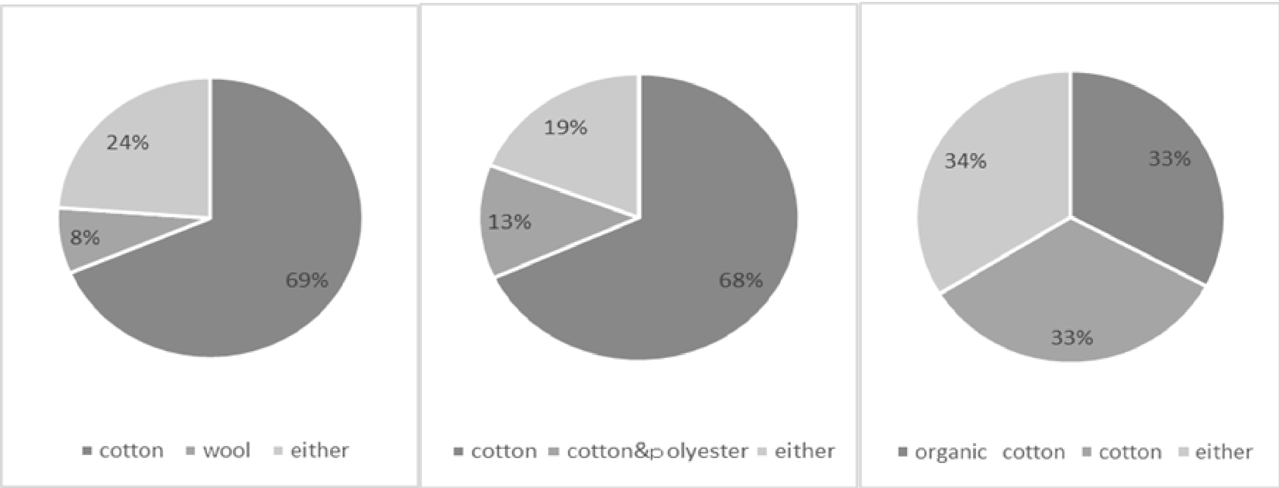
Using selected words list which include the seven most important words to express baby's wear material properties, the sensory test was carried out for seven characteristic samples. The "feel "of the baby's wear – both positive and negative adjectives were elicited. The seven pairs of bipolar words were prepared and arranged into a grid where each trait was put on the between the extreme values of its poles and could be estimated on a five point scale. The seven pairs were thick/thin, soft/hard, warm/cold, stretching/non-stretching, smooth/rough, humid/dry and preferable/not preferable.

Samples were rated with consumer judges by handle and vision. The results were examined in relation to the samples properties experimentally.

5. RESULTS AND DISCUSSION

5.1. Requirements of consumers

From results of questionnaire investigation carried out before the experiment, the three major motives for the purchase of baby clothes are "good material" "mobility" and "size. Since good materials were regarded as most important, we asked about which materials are required by consumers. For constituting fiber sorts, answers are summarized in Figures 1(a), 1(b) and 1(c), for natural fiber sorts from cotton or wool, for cotton or cotton blend and for normal or organic cotton, respectively. Percentage shows the backing rate of total answers.



(a)Fiber sorts from cotton or wool (b) Cotton or cotton/polyester (c) Organic or normal cotton

Figure 1: Results of questionnaire investigation on desirable materials of baby clothes

5.2. Properties of fabrics applied to baby clothes

Figure 2 shows the compression properties of all the sample groups. LC is linearity of compression power-thickness relation curve. WC is the compression energy when a sample is compressed and RC is Resilience.

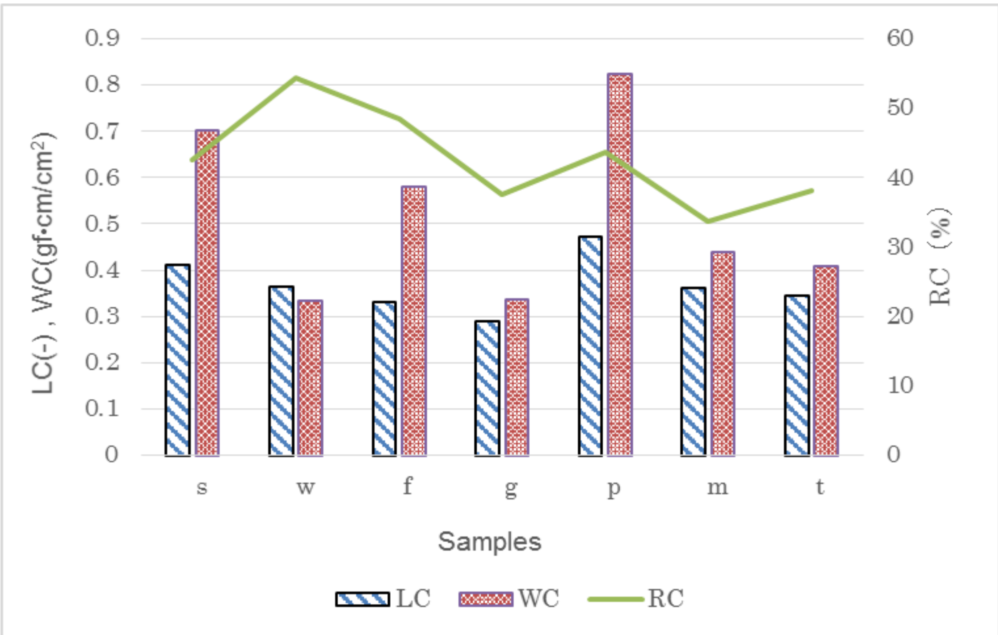


Figure 2: Compression properties measured

Comparing sample G of double gauze to other knitted samples, LC and WC are smallest among all the sample groups. Oppositely sample P that is the knitted fabrics with piles shows largest LC and WC, comparing with other groups. From the measured results of compression resilience RC, wool 1x1 interlock fabrics has the highest RC, then it has high recovery nature after deformed. Plain knitted, mesh, gauze groups show the small RC, then these group fabrics have less recovering ability after once deformed.

5.3. Air resistance and water absorption

Air resistance is smallest for G and M groups and largest for 1x1 interlock group as shown in Figure 3.

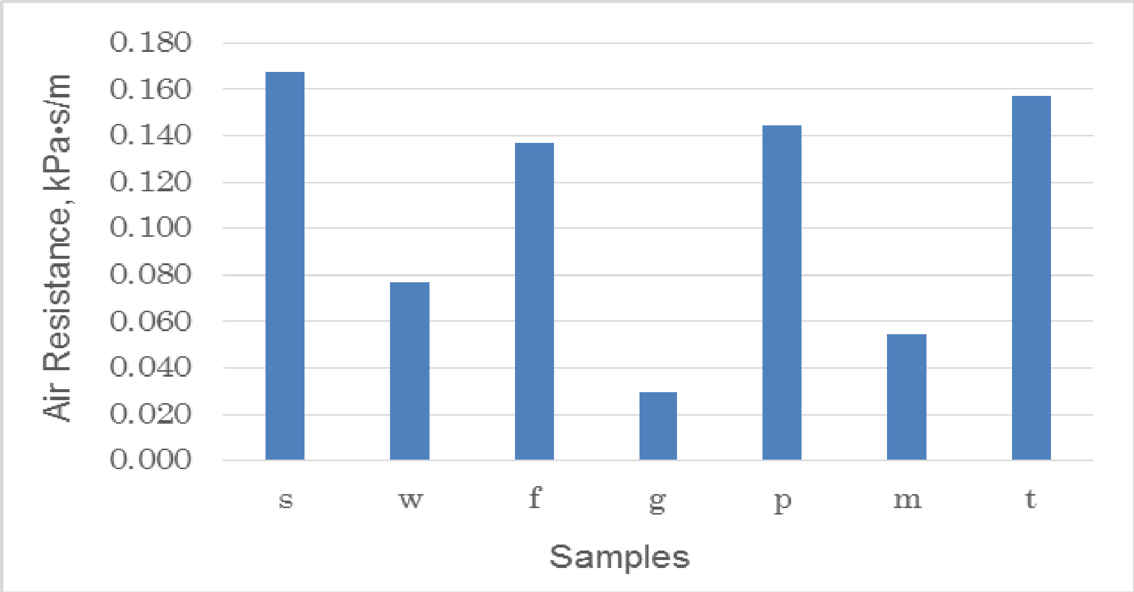


Figure 3: Air resistance

The changes of moisture absorption measured at regular intervals are plotted for four samples of groups, and mesh, and Gauze samples in Figure 5. Samples s7, s8 and w are sold for winter use and the sample s1 and mesh sample m is for summer use.

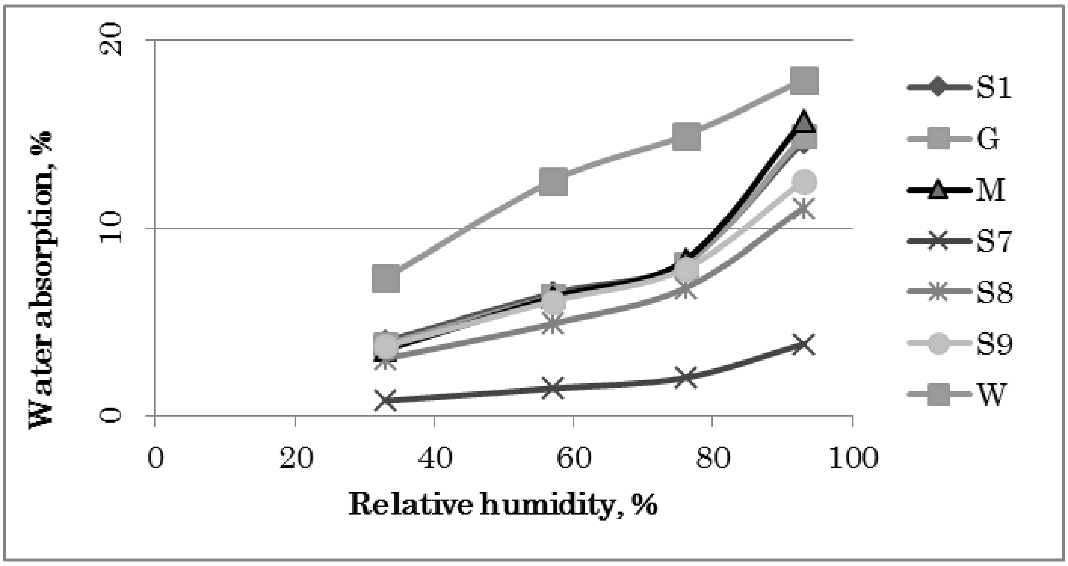


Figure 4: The changes of water absorption

The sample w, which is made from wool 1x1 interlock structure, has the highest water ability to absorb. Wool fiber nature affected this result. The sample s7 shows the lowest ability to absorb moisture. Both mesh and gauze samples indicated the rapid increase of water absorption at more than 80% relative humidity. On the whole, relative thick materials like s7 and s8 is suitable for winter wear and thinner materials m and gauze fabrics is good for summer clothes in Japan. Wool knitted fabrics has a wide range application to every season.

5.4. Sensory test profile

Scores for impression of samples rated by judges in the sensory test are shown for each sample in Figure 5. The seven pairs were thick/thin, soft/hard, warm/cold, stretching/non-stretching, smooth/rough, humid/dry and preferable/not preferable. They are plotted in each figure from sample to sample. Respondents felt that thicker(thinner) fabrics were warner(colder). Samples s7, s8 and s9 were rated as to be very thick and slightly humid. Oppositely, sample m and gauze were estimated as very /slightly thin and slightly dry. For surface touch feeling, samples s1 of cotton fibers provides smooth feeling to respondents.

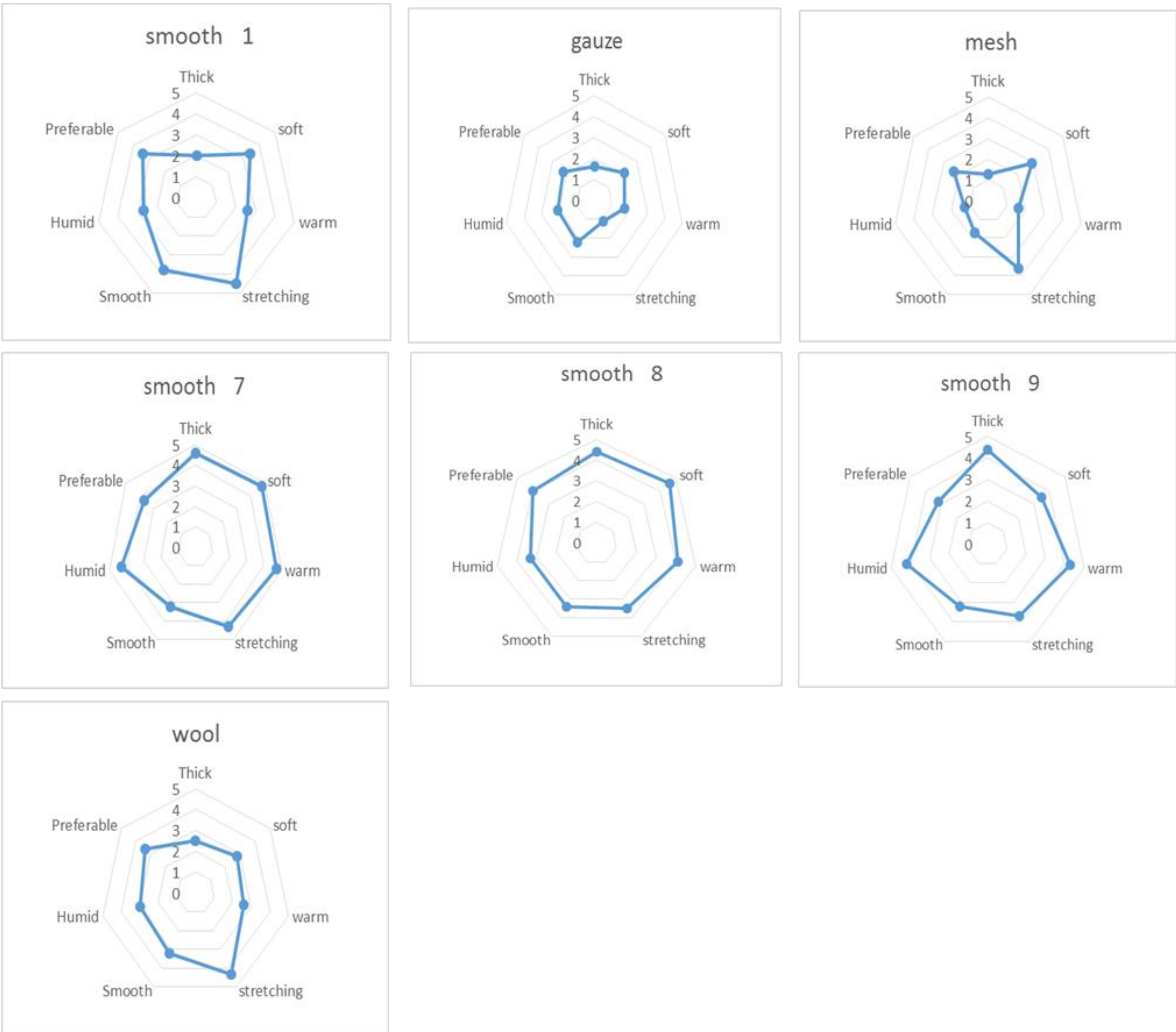


Figure 5: Sensory test profiles

From the result of a survey questionnaire, it is obvious that the require the functions of self wears to be good designed, price and sizes, with wishing baby clothes to be from good materials, comfort and good to act. Good price is required both wears. For consistent fiber sorts, cotton is judged to be suitable in baby's wear. Then we selected typical baby clothes of different structure and consistent fibers. In the experiment, tor those samples, structural property, mechanical property, air and water permeation properties were measured. Results of the experiment were analyzed in relation to that of sensory test. The strong relations were explained in Figure 6.

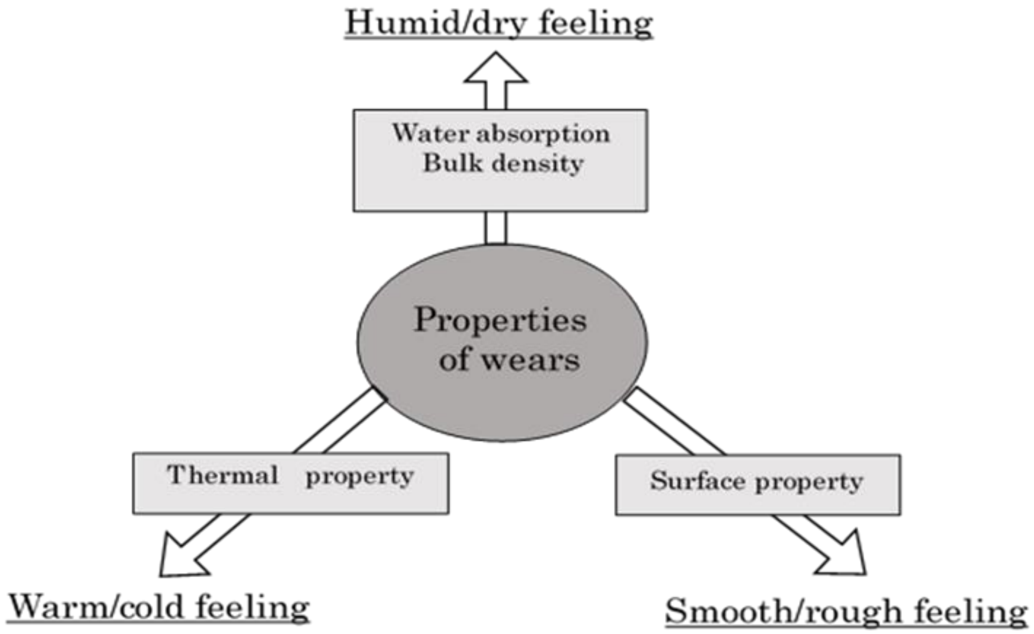


Figure 6: Relation of sensorial feeling and properties of samples measured in the experiment

Correlation coefficient of humid/dry score and water absorption at 93%RH is -0,716; smooth/rough and SMD is -0.588; warm/cold and thickness is 0,936.

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BIOGRAPHY

A.Ukegawa's synopsis is:

Aya Ukegawa is a senior student of Hokkaido University of Education in Japan and majoring in clothing material science and Kansei engineering. She has studied on the objective evaluation of clothing materials for two years. She is a chief editor of the free university magazine. Her hobby is watching movies.

T. Fujimoto's synopsis is:

Dr. Takako Fujimoto belonged to 1) Niigata University (1977-1981), and then has belonged to 2) Hokkaido University of Education (1992- at present) and has been professor since 1992. She has been i) Head, Japan Section of The Textile Institute of UK (2005-), ii) a member of council of TI, iii) a council member of Japan Research Association for Textile End-uses, iv) a visiting professor, University of New South Wales, Australia (1996.9-1997.3). Her major research areas in scientific achievement are a) theory of heat transfer of fibrous materials, b) mechanical properties and handle estimation of clothing fabrics, c) objective evaluation of clothing materials, d) durability of clothing materials. The number of her published original books is 5, of her published original papers and articles is around 130. She received three prizes and awards related to the above scientific achievements.

Y. Okamura's synopsis is:

Dr. Yoshimi Okamura graduated from the master course of Nara Women's University in 1977. She belonged to several junior colleges in 1977-1999. She has been a professor of Miyazaki University since 2000. Her researches are on i) the drawing and heat treatment on surface free energies of polyethylene terephthalate fibers, ii) Capillary wetting rate in nylon fibrous assemblies and iii) dyeing mechanism of cellulose fibers.