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Modification of Textile Materials' Surface Properties Using Chemical Softener

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In the present study the effect of technological treatment involving the processes of washing or washing and softening with chemical cationic softener "Surcase" produced in Great Britain on the surface properties of cellulosic textile materials manufactured from cotton, bamboo and viscose spun yarns was investigated. The changes in textile materials surface properties were evaluated using KTU-Griff-Tester device and FEI Quanta 200 FEG scanning electron microscope (SEM). It was observed that the worst hand properties and the higher surface roughness are observed of cotton materials if compared with those of bamboo and viscose materials. Also, it was shown that depending on the material structure the handle parameters of knitted materials are the better than the ones of woven fabrics.
Keywords: textile, cotton, bamboo, viscose, handle, SEM, washing, softening.

1. INTRODUCTION

Touch sensation of textile material as well as final garment is defined as textile hand. That property of textile is modified usually during their industrial finishing. Textile finishing influences the changes in stiffness as well as in softness of textile materials increasing tactile comfort during wear [1]. Additional changes in textile properties appear during their wearing process after their laundering. And these changes are very dependent on the mode of this care process, i. e. applying or no chemical liquid softeners in textile rinsing process. Notwithstanding that cationic chemical softeners were born in the middle of twentieth century whereas they were not applied widely in textile care processes up till the end of this century [2]. But it is known that the molecules of softener can be deposited on fiber surface during defined time that is dependent on the ionic (cationic) nature of softener molecule as well as on the level of fiber surface hydrophilicy. Every effective chemical softener contains a cationic surfactant that increases the softness of textile material as well as lubricates its fibers [1, 3]. The changes in textile surface, mechanical or physical properties after textile materials' washing as well as after their rinsing in pure water or with chemical softeners were considered in previous research works carried out by different scientists [4 – 14]. The great interest attend on the new generation of textile fibers such as bamboo that still is not deeply investigated, but is known that the presence of this fiber in textile structure enhances fabric's hand [4, 15]. Whereas the information analyzing the properties of bamboo fiber treated by washing and chemical softening is still very poor. The published information shows that the applying of cationic softeners in textile products process influences the smaller or higher changes in their properties that are dependent on the fiber composition of textile material. And, even very slight changes in textile surface properties can be evaluated objectively using instrumental methods based on the extraction of a disc-shaped specimen through a central nozzle [15 – 16].

The aim of this research is to estimate the influence of washing as well as washing together with softening using liquid cationic softener on the changes in handle parameters as well as in surface morphology of cellulosic knitted and woven materials manufactured from cotton, bamboo and viscose spun yarns.

2. MATERIALS AND METHODS

Knitted and woven cellulosic materials manufactured from cotton, bamboo and viscose spun yarns were investigated in this research. The structure parameters of these materials are presented in Table 1.

The one part of samples of investigated textile materials were washed using home washing machine "Whirpool" at 95 °C washing temperature T and the others after the same washing process were additionally soaked in water containing the cationic chemical softener "Surcase" (Great Britain) in a laboratory bath for 20 minutes. The dosage of chemical softener was selected according recommendations of softener's producer and was 18 ml per 10 liters of water. After technological treatment the samples were dehumidified in centrifugal dryer with followed drying in horizontal position. From prepared material samples the disc-shaped specimens of R radius that was equal to 56.5 mm were cut. Number of specimen in each tested material group varied from 5 to 8. The coefficient of variation varied from 5 % to 8 %.

The effect of washing as well as washing together with softening using liquid cationic softeners on the ratio of textile surface modification should be considered analyzing textile materials surface properties as well as their mechanical properties as both affect textile surface properties, especially their softness. Mechanical properties of investigated materials were tested using KTU-Griff-Tester device [4, 5, 8, 13] and were estimated from primary hand parameters such as maximal extracting force P_{max}, tangent tgα of the slope angle of initial part of extracting curve H-P (deformation-force) and extracting

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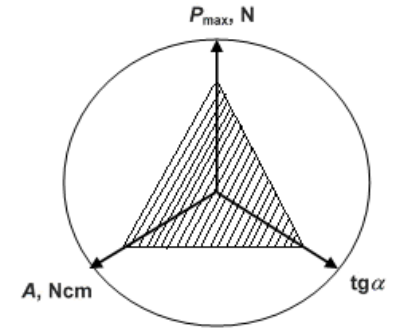
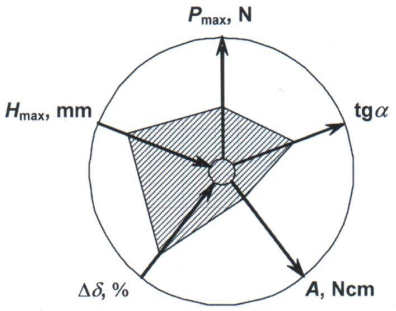
Table 1. Structure parameters of investigated textile materials

Material code	Composition	Weave (knit type)	Thickness δ, mm, under pressure p = 0.5 kPa	Surface density, g/m^2
A 01	100 % cotton	Plain	0.33 ±0.01	144.4 ±0.4
A 02	100 % bamboo	Plain	0.53 ±0.01	218.4 ±1.2
T 03	100 % cotton	Plain jersey	0.57 ±0.01	177.1 ±1.2
T 04	100 % bamboo	Plain jersey	0.50 ±0.01	176.9 ±1.5
T 05	100 % viscose	Plain jersey	0.36 ±0.01	128.4 ±1.7



a



b

Fig. 1. Scheme of complex hand Q parameter's calculation: a – for woven, b – for knitted materials

work A for woven fabrics and P_{max}, tgα, A, specimen H and changes in materials' thickness $\Delta\delta$ for knitted materials as well as from Q complex hand parameter (Fig. 1).

The morphological changes in fabrics' surface occurring because of different material treatment were examined using FEI Quanta 200 FEG scanning electron microscope.

3. RESULTS AND DISCUSSION

The washing and washing together with softening of investigated fabrics increases hand parameters if compared them to those of control (unwashed) textile materials (Fig. 2). After materials washing without softening with chemical liquid softener the extracting force P_{max} increases from 25 % to 114 %, the tangent tgα of the slope angle of initial part of extracting curve H-P – from 2 % to 34 %, the extracting work A – from 48 % to 125 %. The chemical softening using liquid cationic softener decrease the values of hand parameters of washed and rinsed in pure water textile materials in the following order: the extracting force P_{max} decreases from 1.2 to 1.8 times, the tangent tgα of the slope angle of initial part of extracting curve H-P – from 1.1 to 1.4 times except the ones of T03 material that remain almost unchanged as well as of T02 material that increases in 1.2 times, the extracting work A – from 1.1 to 1.7 times and the complex hand parameter from 1.4 to 9.25 times. Besides, it was noticed that the complex hand parameter Q of T04 and T05 knitted materials even decreases in 29 % and 17 %, respectively, if compared to those of control specimens (Fig. 2, d). Supposedly, the decrease in handle parameters after textile softening appeared because of increased material softness and surface smoothness.

The maximal changes in P_{max}, tgα, A and Q handle parameters were determined for A01 cotton woven fabric excluding the changes in tangent tgα of slope angle of initial part of extracting curve H-P for A02 bamboo woven fabric as well as changes in Q complex handle parameter of T05 viscose knitted material. The highest changes in hand parameters of treated viscose knitted material were observed if compared it to others knitted materials, supposedly because of higher susceptibility of viscose fibers to treatment processes than most other fibers as they have lower crystallinity index than other regenerated cellulose and cotton-based fabric, i. e. 50 % – 60 % amorphous regions are accessible to physico-chemical interactions while they are 20 % for cotton [17, 18]. The opposite tendencies were determined for A02 bamboo fabric exhibiting the increase in P_{max} extracting force after its washing and softening. It means that after such type of textile treatment it became rougher.

After softening Q complex parameter of A01 woven fabric decreased in 9.3 times as well as one of T05 knitted fabric decreased in 8.2 times if compared to rinsed in pure water materials. The primary parameters of knitted materials' extracting through a nozzle are lower than ones of woven fabric because of looser structure of knitted materials that influences the higher structure mobility and softness.

So, it was proven that cationic softener "Surcase" could improve textile hand if compared with washed materials as well as with control materials' specimens. So, the usage of rinse cycle liquid cationic softeners substantially qualifies reduction of hand rates [7 – 8].

The comparison analysis of surface morphology of investigated fabrics has shown the presence of differences between washed materials (Fig. 3, a–c) and washed and rinsed with chemical softeners materials (Fig. 3, d, e and f). The prominent flutes oriented towards fiber longitudinal axis are observed on the surface of washed materials.

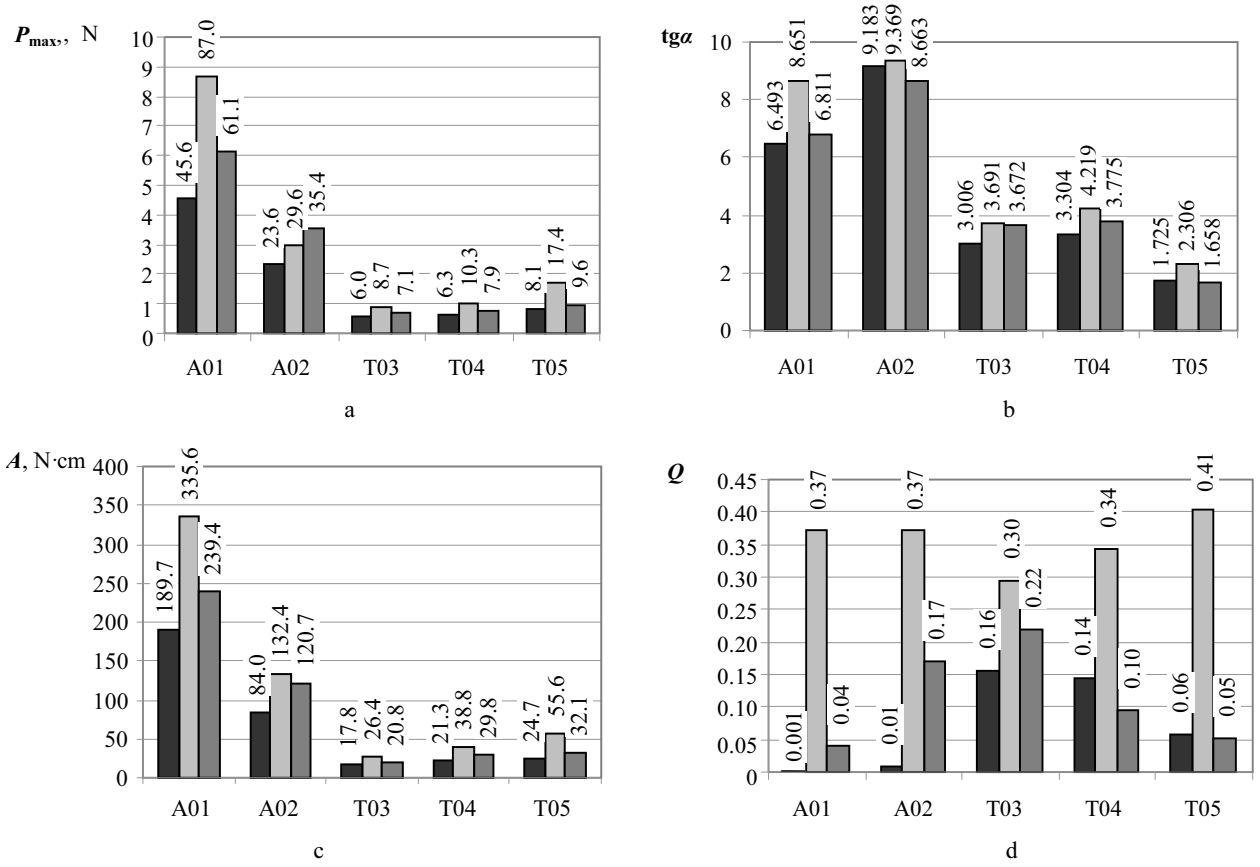


Fig. 2. The hand parameters P_{max} (a), tgα (b), A (c) and Q (d) of washed and washed with followed chemical softening of woven fabrics A01, A02 and knitted materials T03,T04 and T05: ■ – control, ■ – washed, ■ – washed+softened

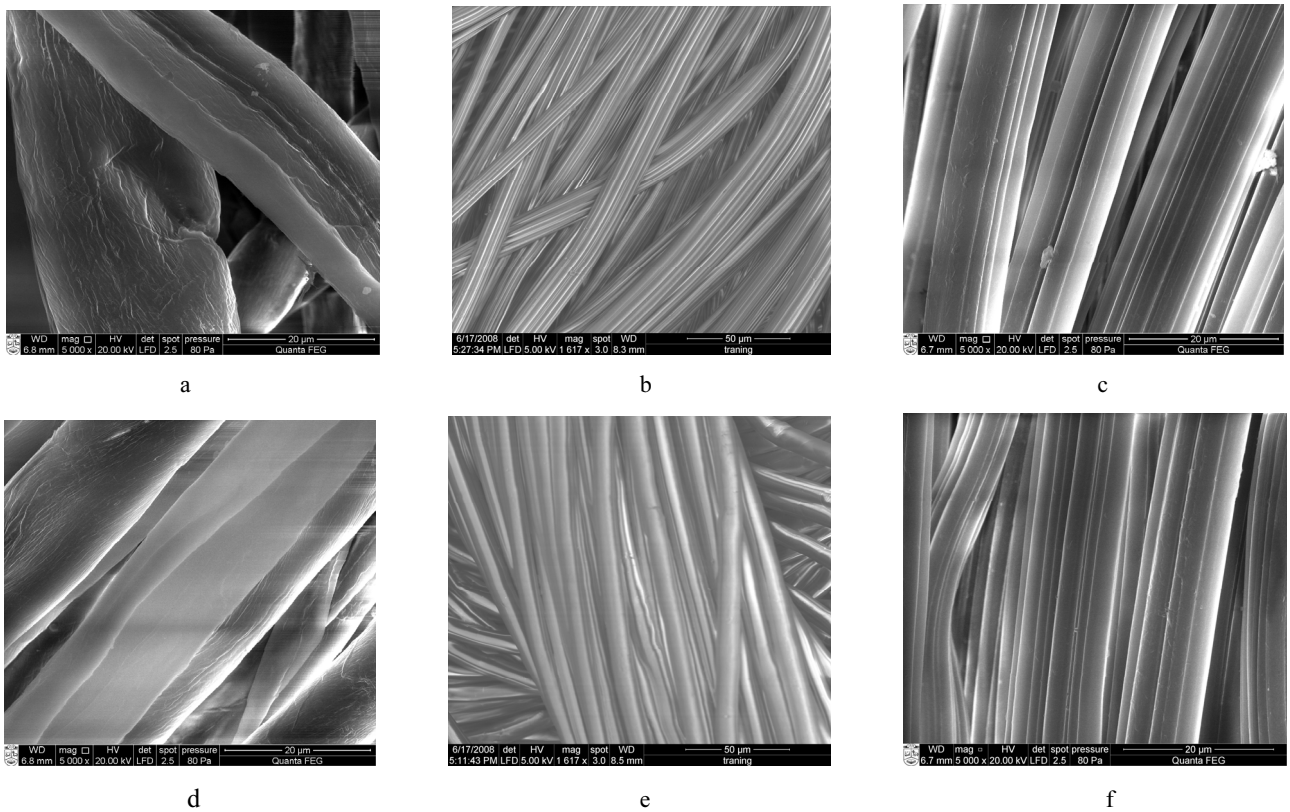


Fig. 3. Surface morphology of cotton A01 (a, d), bamboo T04 (b, e) and viscose T05 (c, f) textile materials after washing (a, b, c) and washing together with softening (d, e, f)

If compared among themselves all washed cotton, bamboo and viscose textile materials, it can be seen that the surface of viscose material is the smoothest (Fig. 3, c). The chemical softening evidently increases the smoothness of all investigated materials, especially of bamboo material (Fig. 3, e) that before softening displayed a tubular and ribbed longitudinal surface (Fig. 3, b). The increased smoothness of bamboo material's surface after softening process could be influenced by its structure that is relevant to amorphous and leads superior hygroscopicity [9].

4. CONCLUSIONS

1. It was proven that the washing and washing together with softening of cellulosic woven and knitted materials increases the primary hand parameters of control (unwashed) materials. And, if compared treated materials among them it can be seen, that determined increase is lower for fabrics softened with cationic softener "Surcase". It was observed additionally, that the complex hand parameter Q of T04 and T05 knitted materials even decreases if compared with those of control specimens.
2. Based on the results obtained, it was found that the worst hand property have cotton woven fabric if compared them to bamboo and viscose materials.
3. The presented investigation confirmed that the values of primary hand parameters P_{max}, tgα and A of knitted materials are the lower than of woven materials.
4. The comparison analysis of surface morphology of investigated materials has shown that chemical softening significantly increases their surface smoothness.

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