ASPECTS REGARDING FINISHING OF LYOCELL WOVEN FABRICS

Petronela Drambei
The National Research-Development Institute for Textile and Leather
Department of Textile Mechanical Processing
Str. Lucreţiu Pătrăşcanu Nr. 16, Sector 3, 74674 Bucureşti, România
Phone: +40213404200/152, Fax: +40213405515, E-mail: drambei@xnet.ro

Alina Popescu
The National Research-Development Institute for Textile and Leather
Department of Textile Chemical Processing
Str. Lucreţiu Pătrăşcanu Nr. 16, Sector 3, 74674 Bucureşti, România
Phone: +40213404200/115, Fax: +40213405515, E-mail: alina@ns.certex.ro

Mihai Ciocoiu
Technical University "Gh. Asachi", Textile Faculty
Bd. Dumitru Mangeron Nr. 53, 6600 Iaşi, România
Phone: +40232278683/1136, e-mail: mciocoiu@tex.tuiasi.ro

Abstract

Lyocell fibres have made a special impact on the worldwide textile market since their appearance. The trends in the field of textile fibres and the necessity of increasing the competitiveness of textile articles motivated an analysis of lyocell fibres' potential for the garment sector, and especially for fashion. To this end, some different finishing experiments on lyocell woven fabrics have been conducted.
The technological experiments had the primary fibrillation effect-enzymatic defibrillation-secondary fibrillation in view. For obtaining these effects, rope finishing with/without woven fabrics causticising was carried out, followed by defibrillation (biopolish treatment) before or after dyeing, using different cellulasic enzymes such as Bactosol CA (Clariant), Perizym 2000 and Perizym LYO (Textil Chemie GmbH Dr. Petry).
The experiments considered the evidence of the influence of these technological stages on the surface modification that appears in finishing lyocell textile materials.

Keywords: *lyocell woven fabrics, fibrillation, finishing processes, enzymatic treatments*

1. General considerations

It is known that lyocell fibre is a cellulose regenerated fibre, with a complex structure consisting in micro- and macrofibrils, highly oriented along the length of the fibre axis [1, 2, 3].

During wet treatments and home washings, the fibrils are broken and move to the surface of the woven fabric. This surface modification is named fibrillation [3, 4].

Lyocell fibres display a higher tendency to fibrillation compared with other cellulosic fibres because they have a higher degree of crystallinity on the fibre length (90% for lyocell, in contrast with 60-70% for viscose fibres) [3, 4].

Possibilities for finishing lyocell woven fabrics are multiple: from preventing the fibrills forming (when classical woven fabrics result) up to enzymatic treatments and/or treatment in a tumbler apparatus (AIRO 1000-Biancalani/Italia) resulting in 'peach-skin', characterised by a very smooth and bulk effect [5, 6, 7, 8].

In order to remove the primary fibrillation, in washing, whitening or dyeing, it is necessary to apply enzymatic treatment with the use of special cellulasic enzymes. Enzymatic treatment, doubled by a controlled mechanical action, lead to a complete and of long duration defibrillation [9,10,11,12,13].

The main conditions for accomplishing reproducible technological processes with good results are coordination of the structure parameters of the woven fabric (yarn twist, thickness etc.), use of specific chemical auxiliaries (antifolds and antislip finishing agents, cellulase-type enzymes) and the type of the finishing machine and the finishing process, according to the surface effects.

Within the wet finishing processes, a fast secondary effect appears at the beginning, namely a primary fibrillation named macro-fibrillation with irregular long staple, which caused the woven fabric to be smoothed. The technological processing stage at which this primary fibrillation is removed is the key to the lyocell woven fabrics' finishing.

The secondary fibrillation, named the short staple fibrillation, is more uniform; it is carried out in a 'wet and dry' finally treatment on fast rope finishing machines, for example with the use of AIRO (Biancalani), or ROTO-Tumbler (Thies).

Insufficient fibrillation of a woven fabric within the finishing processes can lead to undesirable effects, which consist in a supplementary fibrillation in subsequent wet treatments, for example in home washings.

A high degree of fibrillation leads to interesting touch or optic effects, but the control of the dyeing and finishing processes is hard to accomplish.

Besides the specific fibrillation property of the lyocell fibre, there are also other parameters that influence the fibrillation tendency of a woven fabric.

Factors that increase fibrillation:
- small yarn torsion;
- small thickness of the woven fabric;
- high temperature;
- strong mechanical stress; and
- small bath ratio.

Factors that decrease fibrillation:
- reduced mechanical actions;
- use of antifolds and antislip finishing agents;
- singeing before and after dyeing;
- cellulase-type enzyme treatment; and
- superior finishing with resins.

The aspects presented in this article represent a new approach regarding enzymatic treatment and emphasise the influence of the enzymatic treatment stages on the surface modification of lyocell woven fabrics.

2. Finishing technological experiments on 100% lyocell woven fabrics

Finishing technological experiments were carried out on 100% lyocell woven fabrics with the following structures: crêpe binding, with Nm 85/2 yarns in warp and weft and cloth binding, with Nm 54/2 (with flame effects in the yarns), both in warp and weft.

The technological experiments had the primary fibrillation effect-enzymatic defibrillation-secondary fibrillation in view [8, 9, 10, 11, 12, 13]. To obtain these effects, rope finishing was carried out with/without woven fabric causticising., followed by defibrillation (biopolish treatment) before or after dyeing, using different cellulasic enzymes such as Bactosol CA (Clariant), Perizym 2000 and Perizym LYO (Textil Chemie GmbH Dr. Petry).

Micro-fibrillation (secondary fibrillation) has been evidenced by the treatment of the textile fabric in a lab apparatus which has a perforated cylinder (carried out by the specialists from our institute). This apparatus ensures strong mechanical stirring, using a special product named SIRRIX LUNA for the

treatment; this is a bio-microlite in which a cellulasic enzyme is encapsulated. The procedure was proposed by the Clariant specialists and was named 'telluric treatment'.

The finished woven fabric variants differ in the function performed at the individual technological stages carried out and their place in the technological flow chart. The experiments consider the evidence of the influence of these technological stages on the surface modifications that appear in finishing the lyocell textile materials.

Thus, the following variants have been examined:

- with and without causticising, to evidence the primary fibrillation effect which is induced by this stage;
- with enzymatic defibrillation before and after dyeing, to evidence the influence of the enzymatic product on the surface modifications that appear, respectively for removing the micro-fibrils that are forming during this technological stage;
- with and without biomechanical treatment to evidence the complete defibrillation that can be obtained by accomplishing this stage;
- with and without emollient treatment, to check the influence of the emollient against the final quality of the textile material treated; and
- classical, with the prevention of fibrils forming.

The technological procedures used for the mentioned variants of processing lyocell woven fabrics are presented in Table 1.

Table 1. Specification of the technological procedures used at the individual stages of the finishing process of lyocell woven fabrics

Nr. crt.	Variants/ Technological stages	Crêpe binding woven fabrics							Flame woven fabrics - cloth binding			
		1	2	3	4	5	6	7	8	9	10	11
1.	Washing	x				X	x	x*	x	x	x	x
2.	Causticising		x	x	x			x				
3.	Enzymatic defibrillation before dyeing		x	x	x							
4.	Optical whitening	x										
5.	Dyeing		x	x	x	X	x	x	x	x	x	x
6	Enzymatic defibrillation after dyeing					X		x		x	x	x
7.	Biomechanical treatment with: - Sirrix Luna and Bactosol - Perizym 2000			x	x		x					
8.	Tumbler processing (AIRO 1000)										x	
9.	Emollient treatment	x	x	x	x	X	x	x			x	x
10.	Drying: - on frame - on tumbler	x	x	x	x	X	x	x	x	x	x	x
11.	Smoothing							x		x	x	x

* After causticising process

The decisions regarding the selection of the finishing technological stages were influenced by the following considerations:

- Causticising (with a NaOH solution 6-8º Bé) produces primary fibrillation of the woven fabric (macro fibrillation).
- Whitening. The whiteness degree of lyocell fibres is generally high, this being enough for a textile material which will be dyed.
- Dyeing. For dyeing lyocell fibres, all dye stuffs for cellulosic fibres (direct, reactive dye stuffs etc.) can be used. Lyocell fibre has good absorption speed of the dye stuff and good dyeing efficiency, in contrast with other fibres.
- Enzymatic defibrillation. For removing the macro fibrils which form during washing, whitening or dyeing, a treatment with a special cellulasic enzyme is carried out. This treatment, doubled by a controlled mechanical action (on AIRO dynamic machines of air-jet type), can lead to complete defibrillation and its long duration on the fibres [14, 15, 16, 17].

The scanning microscopy analyses evidence the following aspects [8, 9, 10]:

- In the case of dyeing, macro- and micro-fibrils irregularly placed appears (Figure 1).
- On the crêpe binding woven fabric, treated with Sirrix Luna and Bactosol CA, the agglomerate fibrils existing from the dyeing stage are maintained, but a uniform intensive fibrillation (Figure 2) appears, thanks to the combined effects of the mechanical stirring by means of the enzyme treatment apparatus and the bio-mechanical abrasion of the product mentioned.
- The emollient produces a decrease in the fibrillation.
- After woven fabric treatment with Perizym 2000 or Perizym LYO, the fibril agglomerates disappear, and the number of the fibrils is reduced, a fact that demonstrates the enzymatic defibrillation effect (Figure 3).
- For the dyed woven fabric, enzymatically treated by means of jet and AIRO 1000 and respectively dried on AIRO (Figure 4), the percentage of fibrillated fibres increases, but there is no generalised fibrillated structure, a fact that can be explained by reducing the fibrillation capacity because of the mechanical action.

Figure 1. Dyeing stage - unirregulary macro and micro fibrils

Figure 2. Treatment with Sirrix Luna and Bactosol CA - uniform fibrillation

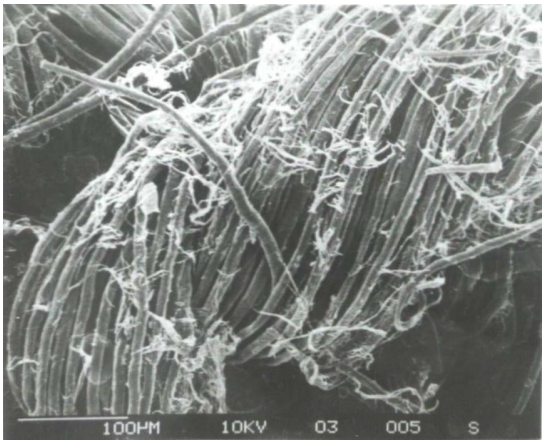

Figure 3. Treatment with Perizym 2000 or Perizym LYO – enzymatic defibrillation effect

Figure 4. Enzymatic treatment on jet, AIRO 1000 and dried on AIRO

It should be emphasised that the mechanical properties of lyocell fibres after enzymatic treatment decrease within the range of 20 – 30 %. Considering this behaviour it is highly recommended to choose a good correlation of the specific auxiliaries used with the type of finishing processes and machines applied.

3. Conclusions

The finishing experiments on lyocell fibre woven fabrics have allowed the following observations:

- The finishing of lyocell fabrics requires the use of aero dynamic systems, jet type (Then Airflow, Thies Luft-Roto, Laip Airflow), or discontinuous rope treatment (AIRO 1000, Roto-Tumbler), with a high circulation speed of the textile material (600-1000 r.p.m.).
- On the rope finishing of the woven fabrics with the mass/m^2 <200 g, antifold products with performant properties have to be used, in order to prevent permanent folds.
- The presented finishing variants for 100% lyocell woven fabrics represent only a part of the real possibilities for the chemical processing of these woven fabrics.

References

[1] Eichinger D., Eibl M., Lenzing Lyocell - An Interesting Cellulose Fibre for Textile Industry, Lenzinger Berichte, nr. 75, 1996, p. 41

[2] Eichinger D., Lenzing Lyocell - Potential for Technical Textiles, Lenzinger Berichte, nr. 75, 1996, p. 69

[3] Marini I., Fibrillation, Textilveredlung 9/10, 1996, p. 194

[4] Kampl R., Schaumann W., The finishing behavior of cellulosic man-made fibres of the second and third Generation, Lenzinger Berichte, nr. 75, 1996, p. 91

[5] Breiner R., Die Strangveredlung von Lyocell – aktueller Stand der Praxis, Textilveredlung, nr. 9/10, 1996, p. 187-190

[6] Nicolai M., The Influence of Finishing Processes on Fibrillation Behavior of NMMO Fibres, Textilveredlung 5/6, p. 96

[7] Kampl R., Leitner H., Processing Behavior and Applications of Lyocell, Lenzinger Berichte, nr. 75, 1996, p. 97.

[8] Bartsch P., Comment reduire la fibrillation Lenzing Lyocell, L'Industrie Textile, nr. 1304 decembre 1998, p. 61

[9] Brauneis F., Möglicheiten der Lenzing Lyocell Fasern für den kreativen Textilveredler, Lenzinger Berichte 75/96,105

[10] Hoffmann F., Das färberrische Verhalten von Lenzing Lyocell – bei Einsatz von Reaktiv- und Direktfarbstoffen im Ausziehverfahren, Lenzinger Berichte 75/96, 113

[11] Eibl M., Vernetzung von Lenzing Lyocell, Lenzinger Berichte 75/96, 112

[12] Breier R., Die Strangveredlung von lyocell. Actueller Stand der Praxis, Lenzinger Berichte 75/96, p. 108

[13] Mieck K.P., Die Nassscheuerbeständigkeit cellulosischer Gewebe als Ausdruck der Fibrillierneigung der Fasern, Lenzinger Berichte 76/97, p. 103

[14] Hohberg T., Finishing lyocell (part 1), Melliand Textilberichte, nr. 4, 1998, p. E66

[15] Hohberg T., Finishing lyocell (part 2), Melliand Textilberichte, nr. 5, 1998, p. 334

[16] Hohberg T., Finishing lyocell (part 3), Melliand Textilberichte, nr. 6, 1998, p. 452

[17] Mieck K.P., Nicolai M., Nechwatal A., Finishing behavior of lyocell fabrics, Melliand English, nr. 5/1997, p. E69