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FE-SEM COMPARATIVE STUDY ON SURFACE MODIFICATION OF WOOL FIBER AFTER DIFFERENT CHEMICAL TREATMENTS

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Abstract: *Wool surface comprehends numerous scales which are responsible of certain undesirable behavior of this fiber during its use and maintenance. One of the most significant issues is related to shrinkage, caused during washing, as a consequence of friction between the fibers. Chemical modification of wool is considered a useful option to avoid these kind of circumstances. During the last years, multiple alternatives for chemical modification of wool have been studied, comprising enzymes or acids amongst others. In this case of study, three different treatments were carried out in order to evaluate wool morphological appearance. The first treatment was an oxidative procedure, containing Basolan DC and sodium acetate as the main components. The second treatment was accomplished using Lanaperm VPO, a commercial finishing agent for wool fiber that claims to soften its surface. The third finishing process was performed employing Siligen FA, a commercial agent intended to act as an antimigrant for dye baths and also provide a smoother and regular surface. After said treatments, microphotographs of all treated and untreated fibers were taken so that a comparison between final appearance could be done. Analyzing results and conclusions, it can be stated that chemical modification of fiber does change its surface appearance and, consequently, its behaviour.*

Key words: *Oxidation, Lanaperm, Siligen, wool cuticle, scales*

1. INTRODUCTION

Natural protein fibers are formed by animal sources through condensation of α-amino acids to produce repeating polyamide units with various substituents on the α-carbon atom. The sequence and type of amino acids making up individual protein chains contribute to the overall properties of the resultant fiber. Wool is a protein fiber chiefly composed of keratin. It is a natural, highly crimped protein hair fiber derived from different breeds of sheep such as Merino, Lincoln, and Sussex, amongst others [1]. Despite the fact that wool can be used not only for cloths but for upholstery or technical textiles, it is estimated that two thirds of the wool production are focused on the manufacture of garments. Wool is widely known by its properties mailt thermal insulation and moisture retention what makes it to be a fibre which does not retain static electricity. Fineness of wool determines the final use. There is a vast range of fibres fineness. It can vary from 16 microns to 40 micros from the coarse fibres. Fineness is a parameter which will influence the touch of the fabric made of wool. Due to its properties wool has been used for cloths market ans anciently was considered the most resitant to fire. However, synthetic fibres imporved their behavior regarding falmability and wool has been used mainly in garments.

Among all the advantages wool can confer to products made of it, there is a special characteristic of this fibre, the scales. The scales are overlapped on the fibre surface and are observed on every animal fibre including animal hair. They are responsible of the users´sking stinging when wearing that kind of gaments on the skin. If the scales are adhered to the fibre surface they should not confer any side effect on peoples´skin. On the other hand, when scales are slightly opened the user can notice it depending on the skin sensibility. Scales are also respoible of felting. Whe the scales slip over one onether the scales interlock and prevent the fibre from coming back to the original position and offere a felt. Felting can be cosndiered a desired effect for some fabrics and felts can be used in shoues hats and many other goods. Felting shrinkage is a typical property of wool when washed and must be controlled to achieve a washable wool product [2]. Due to the configuration of the cuticle scales on the surface of wool fiber, the mechanical action of aqueous washing causes the progressive entanglement of wool fibers leading to irreversible shrinkage of wool fabric [3]. Smoothing or eroding the cuticle scales lowers the friction between the fibers and therefore can prevent shrinkage. Shrink-resist finishing processes often consist of an oxidation/reduction step to degrade the cuticle scales and/or an additive polymer process to mask the scales [4-6].

It is not conceivable to develop a garment with wool and not having to wash it. Soaps usually confer an alkaline pH to water. Alcaline pH is harmful for proteinic fibres, however, it is not the only one, many oxidative products are used on laundry nowadays. Since oxidative treatment can damage the fiber, plenty of alternative treatments are being tested in order to smoothen wool's surface as well as attempting to avoid shinkragee, causing as less degradation to the fiber as possible. Thus, this comparative study highlights the differences between three different treatments, including oxidative process and two other finishing products comprising Lanaperm VPO and Siligen FA

2. MATERIALS AND METHODS

2.1 Fabric

Wool fabric used was supplied by SDC ENTERPRISES LIMITED according to BS EN ISO 105 F01 standard.

2.2 Oxidative treatment

Oxidative treatment was carried out to degrade the wool scales in order to avoid fabric feltering. It consists of a treatment using the sodium salt of dichloroisocyanuric acid, Basolan DC (Basf, Germany).

Table 1: *Oxidative treatment parameters*

Wetting agent	1% owf
Sodium acetate	1g/l
Acetic acid	0.5 g/l
Basolan DC	5% owf
pH	3-4
Fibre weight	0,20 g
Temperature	Room temperature
Liquor ratio	1:80
Time	Samples were extracted 9 hours

2.3 Lanaperm treatment

Lanaperm VPO (Archroma) is a chlorine-free pretreatment agent for antifelt finishing of textiles made of wool and wool blends, supplied by Archroma. The treatment with this product is supposed to cause a light, superificial attack on the wool fibre. Spreading of the wool scales is said to be reduced which would result in a certain reduction of felting.

Table 2: *Lanaperm treatment parameters*

Lanaperm VPO	5% owf
Fibre weight	0,50 g
Temperature	Room temperature
Liquor ratio	1:80
Time	Samples were extracted after 24 hours

2.4 Siligen treatment

Siligen FA (BASF) is a finishing agent which performs as an antimigrant for pigment pad dye and one-bath pigment dyeing and also claims to impart a softer hand of the fabric.

Table 3: *Siligen treatment parameters*

Siligen FA	5 g/l
Fibre weight	0,50 g
Temperature	Room temperature
Liquor ratio	1:80
Time	Samples were extracted after 24 hours

2.5 Characterization of samples

A Field emission scanning electron microscope (FESEM) ULTRA 55 (ZEISS) was used for observation of surface morphology at direct magnification ranging. Samples were tested at 1 kV. Prior the analysis, samples were gold/paladio coated using Sputter Coater EMITECH mod. SC7620 (Quorum Technologies Ltd.).

3. RESULTS AND DISCUSSIONS

After haveind used fifferent productos on the fibre, in ordet to determine the scales shape or effect some observation was conducted. SEM images of the morphological structure of wool fibers were taken in order to make a visual comparison between different treatments achievements

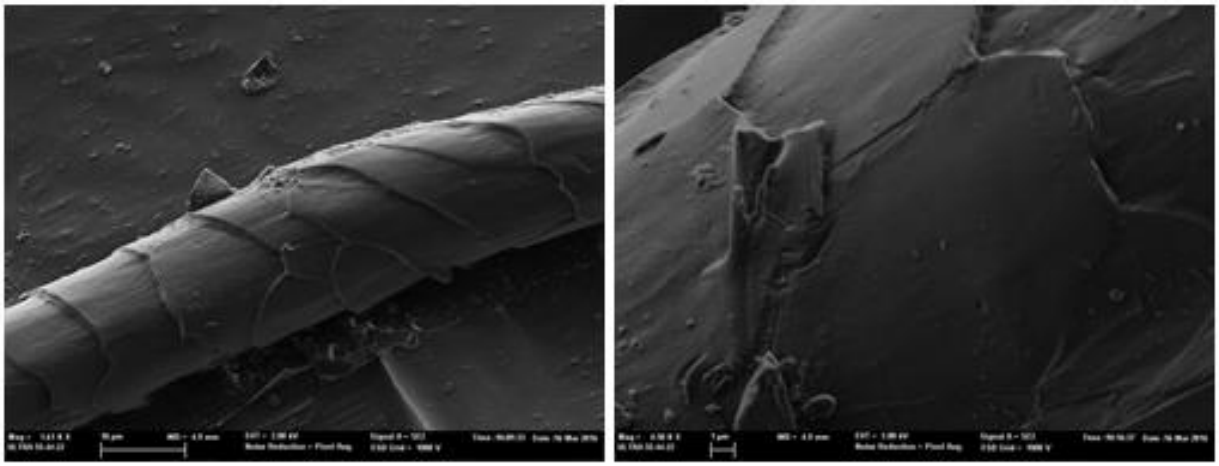

***Fig. 1 and 2**: FE-SEM images of untreated wool fiber*

As explained before, wool is composed of numerous scales, sharp and pointed as seen in the images above (fugures 1 and 2) , which are responsible for wool shrinkage due to friction between them when washing.

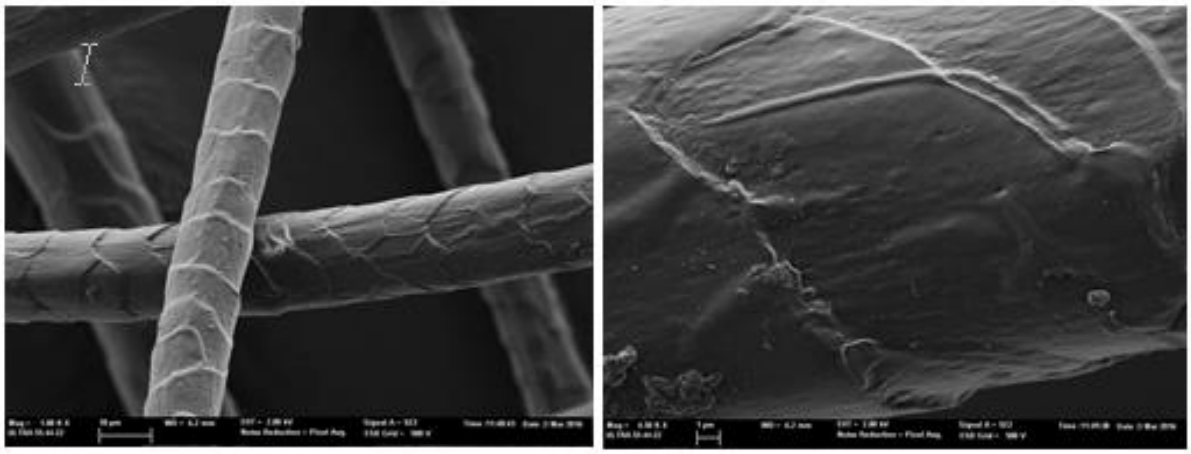

***Fig. 3 and 4**: FE-SEM images of wool fiber after 9 hours of oxidative treatment*

Figures 3 anf 4 show wool fibres at different magnifications range when they have been exposed to an oxidative treatment for a period of time. After nine hours of oxidative treatment, images show that wool surface has been softened, reducing scales' edges. However, this fact would involve a modification in fibre´s properties sucha as weight loss, weakening the fiber etc.

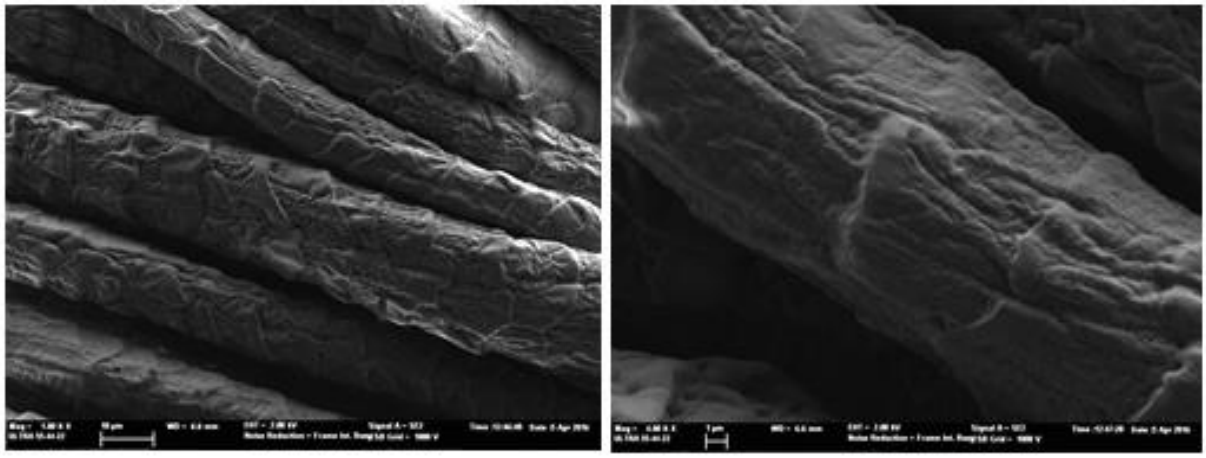

***Fig. 5 and 6**: FE-SEM images of wool fiber after 24 hours of Lanaperm treatment*

Lanaperm does not smoothen surface, but acts by coating it, achieving a soft and wavy surface of a sharpie one. This would mean a reduction of friction while washing, so shrinkage would decrease.

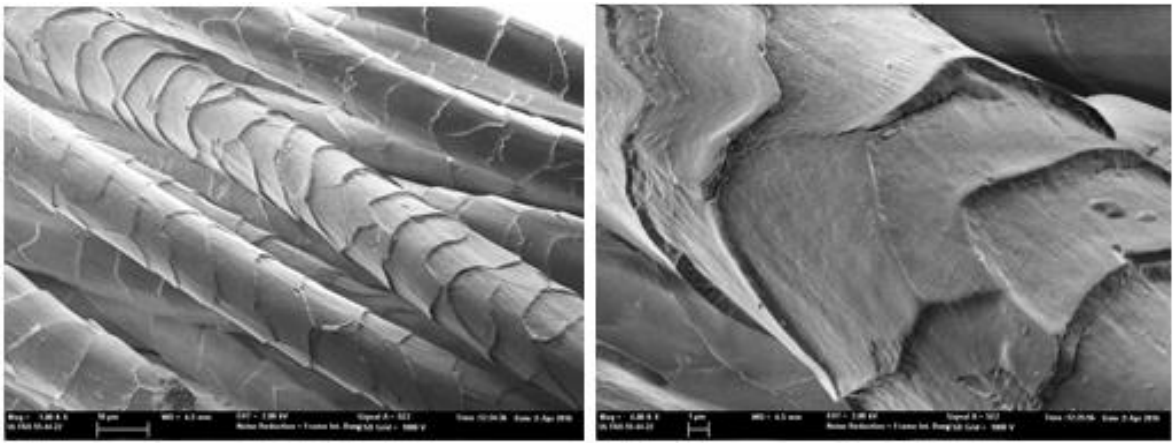

***Fig. 7 and 8**: FE-SEM images of wool fiber after 24 hours of Siligen treatment*

Apparently, from FE-SEM images observation, wool fibers after Siligen treatment do not seem to have had a relevant change, as scales remain almost the same as untreated wool, with certain polishing although not really pronounced. More tests appart from FE-SEM should be conducted to determine its effect.

4. CONCLUSIONS

After the comparative study of these three different wool finishing treatments, it can be said that oxidative treatment is the one that achieves highest degradation of scales, although it is really aggressive to the fiber so its use will not always be suitable for all kind of purposes. On the other hand, Siligen treatment did not make any significant change onto fiber surface, as scales are slightly softened but still noticeable and sharpened, perhaps more concentration was recquired. However, Lanaperm treatment demonstrates a favorable behavior, filling scales edges and smoothing wool's

surface, providing a soft hand and thus avoiding friction. Future studies would be carried out in order to analyse the fibre response and determine the chemicals effect.

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