The effects of lecithin on natural dyeing of plasma treated wool

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1. INTRODUCTION

Wool has a complicated surface structure than the other natural fibers which cause some technical problems such as wet ability (which affecting the dyeability). A lot of disulphide cystine cross linkage in the exocuticle and the fatty acids on its surface cause the wool fiber surface is naturally hydrophobic [1, 2], and the surface morphology of wool fibers are determined the diffusion of liquid in to it [3]. Scientists have been developed many chemical and biological methods for modifying the wool fiber surfaces, such as chlorination [4], polymer deposition [5, 6], and enzyme treatment. These methods are improved the hydrophilic properties of the wool fiber effectively, while the unreacted chemical material can be effluent the environment. Low temperature plasma (LTP) treatment, environmental friendly process, is one of the commonly used physical methods to replace chemical methods for treating wool fibers. Plasma treatment of fibers is confined to the surface of them while the bulk properties are not affected [7]. Plasma treatments have been used to improve adhesion [8], wet ability, dyeability, and some other properties of textiles. Plasma treatment of wool fibers lead to increase the diffusion in to the wool fiber which can reduce the dyeing temperature [9].

2. MATERIALS AND METHODS

Material

Wool fibers with linear density of 200/2 tex was used. They were scoured with1% anionic detergent at 60ºC for 30min, then used at dyeing process. The acetic anhydride, Triton X100, acetone, acetic acid, and hydrogen peroxide were purchased from Merck Company. The commercial soybean lecithin was used for preparing liposomes and commercial aluminum sulphate was used for mordant of wool samples. The madder, Rubia tinctorum, as a natural dye was prepared from the Fars province, Iran. The various madder species of plants from around the world contain a combined total of about 20 different colorants that belong to the hydroxyl-anthraquinone chemical grouping and the most component is alizarin.

Mordanting

The scoured wool sample was immersed in to the prepared mordant solution (fibers: liquor ratio; 1:40) in 40 ºC, according to the recipe which is illustrated in table 1. The temperature of mordant bath rose to boiling point (95 ºC at the laboratory condition) and its gradient was 2ºCmin-1, and it was continued to boiling point. Then, the wool fibers were rinsed with distillated water and dried at room condition

Plasma treatments

Plasma is generally obtained when an electrical discharge passing through a gas. A glow discharge reactor with a radio frequency was used for treatment of wool fibers. Before the plasma treatment, wool fibers should be placed in an oven with 50 ºC temperature and dried for 12 hours for minimizing the water content of wool fibers and then placed in reactor chamber. Oxygen gas was used for the low temperature plasma (LTP) treatment and the flow rate of gas was adjusted to 1.67cm3/s during the LTP treatment. The discharge power and pressure was 80W and 10Pa respectively, and the duration of treatment was 5 and 10 minute, according to experimental design.

Tensile strength

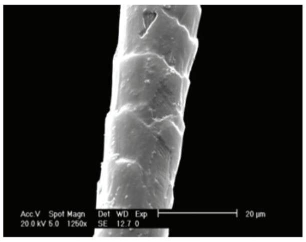
The tensile properties of fibers were measured according to ASTM D 2256. Gage length was 10 cm and crosshead speed was 25 cm/min. The samples were chosen randomly by ten readings for each specimen.

Scanning electron microscopy

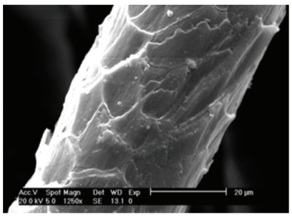
The surface morphology of the wool plasma treated fibers was investigated using a scanning electron microscope (Philips XL30 SEM). All the samples were coated with gold in a sputter coating unit for 5 min before SEM observation.

3. RESULTS

Scanning Electron Microscopy (SEM) micrographs of untreated and LTP-treated wool fibers are shown in Figures 1. Untreated wool fiber in which the scales well defined. It is clearly shows the LTP-treatment has an etching effect on the surface of wool fibers compare to the untreated wool fibers and reduce the scales of wool fibers. In addition, micro cracks were appeared on the LTP-treated wool fiber surface which is indicated the plasma treatments cause some physical alteration in the epicuticle layer of the fiber. Increase plasma duration cause to smoother wool fibers. It is likely that such etching and micro cracks might help to eliminate the hydrophobic surface barrier of the wool fiber, dramatically reducing water penetration time and enhancing initial dyeing rate.



a



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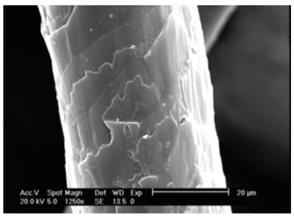

c

Fig. 1. SEM image of wool fiber a) 2.5, b) 5, and c) 10 minute plasma duration

4. CONCLUSION

LTP-treatment has an etching effect on the surface of wool fibers and reduces the scales of wool fiber. LTP-treatment cause micro wool fiber surface which is indicated the creation of some physical alteration in the surface of wool fiber, which dramatically reducing water penetration time and enhancing dyeing rate. In addition, LTP-treatment causes to increase the mechanical properties of wool fibers.

In addition, the results of analysis showed that the actual values were significant in agreement with the predicted values. Dyeing temperature, dyeing time, lecithin concentration, plasma duration, dyeing method, and their interactions are significant model terms, which indicate these factors, have significant effects on the process of natural wool dyeing in presence of lecithin. Moreover, the optimum condition which proposed for the natural dyeing of LTP-treated wool cause temperature dyeing reach to 76.53 °c in presence of acetylated lecithin

5. ACKNOWLEDGMENT

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