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Engineering of Wool Nano-clay Functionalization for Different Approaches

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The research has conducted finishing of wool fabrics by clay nano-layers and its effect on the felting properties of treated wool fabrics. Natural and modified montmorillonite used to modify the fabrics. To this end, the knitted wool fabrics have been treated under ultrasound. Then, the samples have been subjected to felting operation with two acidic and alkaline conditions. Felting properties of samples were investigated and compared with control samples. According to the results, felting properties were affected by nano-clay types and pH. Therefore, nano-clay finishing can increase felting potential, or conversely, increase resistance to shrinkage according to pH of felting solution and nano-clay surface characteristics. Thus, in basis of ultimate goal the required condition can be controlled to boost felting properties or prevent fabric shrinkage.

Keywords: Nano-clay, Felting, Surface Charge, Natural and Organo-modified Montmorillonite.

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1. INTRODUCTION

Montmorillonite is one of the most important and most used kinds of clay especially for the textile modifications [1, 2]. Montmorillonite can be modified to produce different type of organo-clays via cationic ion exchange process. In this way, the montmorillonite with different surface characteristics can be obtained. According to the surface modification, they have different surface characteristics [1, 3]. Then, they demonstrate versatile properties and have different applications [1]. In this study, two types of montmorillonite including modified clay montmorillonite (sodium montmorillonite modified by methyl, tallow, bis-2-hydroxyethyl (Cloisite 30B)), briefly termed 30B, and unmodified clay montmorillonite briefly termed Mt, were used to investigate their effect on the felting properties of wool fabrics.

Hence natural montmorillonite (Mt) has potentiality to be positively charged, to enhance this potentiality, the acidic concision has been selected as the felting media for the fabric treated with Mt to highlighting this special surface characteristic. However, in organo-modified montmorillonite (30B) the potentiality of surface charging has been significantly reduced; then the felting process has been conducted in soap media having middle alkaline condition.

2. EXPERIMENTALS

2.1 Materials

Natural montmorillonite, Cloisite® Na^+ and modified clay montmorillonite (sodium montmorillonite modified by methyl, tallow, bis-2-hydroxyethyl (Cloisite 30B) supplied by Southern Clay Company have been used for nano-functionalization of fabrics. Hydrochloric acid and ethylene-glycol were purchased from Merck Chemical Company and used without more purification.

2.2 Methods

After washing, knitted wool samples were subjected to nano-functionalization under ultrasound using Elmasonic S15H ultrasonic machine, Germany, in a solution containing 0.1 wt% natural montmorillonite in water for 25 min. At the same operation conditions, samples were treated by 0.1 wt% organo-modified nano-clay (30B) in ethylene glycol (EG). Ethylene glycol was used for 30B due to its better dispersibility in EG. The nano-functionalized samples were manually subjected to felting process in acidic and alkaline conditions prepared with a HCL solution (0.1N) and 1wt% anionic soap solution in distilled water, respectively.

3. RESULTS AND DISSCUTIONS

According to the results, the nano-functionalization of samples by 30B caused boosting felting potentiality of wool fabrics as compared to untreated fabrics subjected to the same process. Figure1. shows the fabric contraction through the felting process by soap solution versus time. As shown in this figure, the shrinkage of treated fabrics was faster than the control sample; moreover, the fabric shrinkage of treated fabrics was higher than the control sample. Then, it can be concluded that the

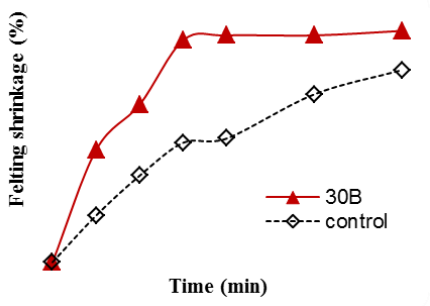

Fig. 1 – Fabric contraction through the felting process by soap solution versus time

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felting potentiality of the nano-functionalized fabrics with 30B has been improved. In this way, the sample treated with the modified nano-clay has more potential to be felt.

Conversely, in the case of sample treated with Mt (unmodified clay) the felting process in acidic condition resulted in decreasing the fabric shrinkage and felting properties (Figure 2). In fact, sodium ions on natural montmorillonite (Mt) can create positive surface charge especially in the applied acidic condition. Then, the positively charged nano-layers, can create a repulsive electrostatic force on the surface of the wool fibers. This prevents efficient contact between fibers and increases the resistance against fabric shrinkage.

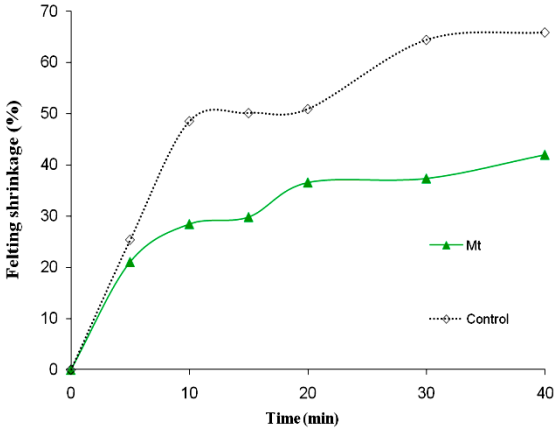

Fig. 2 – Fabric contraction through the felting process by acidic solution versus time

This is really important and useful to control undesirable deformation of wool fabrics during the dyeing and finishing process. Especially in dyeing process, it can prevent appearing the uneven dyeing effects on fabrics resulted by uneven fabric shrinkage during the process. It is really interesting that this effect can appear in acidic conditions, which is commonly used for dyeing of wool fabrics.

4. CONCLUSIONS

In this paper, modified and unmodified clay nanolayers were used to finishing of wool fabrics by ultrasound and the felting potential of treated fabrics as compared to control fabrics was investigated in acidic and alkaline solutions. The results disclosed that nanofunctionalization of fabrics with organo-modified montmorillonite (30B) resulted in improving the felting potential in alkaline condition. In this way, a faster and higher felting process has been performed due to enhance the directional friction effect of wool fibers, as well as, elasticity due to the presence of ethylene glycol. However, Mt nano-clay treated samples interestingly resisted against shrinkage as compared to control sample, felted both in acidic condition, due to positive surface charge created by sodium ions on natural montmorillonite (Mt) especially in the applied acidic condition. These positively charged nano-layers, create a repulsive electrostatic force on the surface of the wool fibers, preventing the efficient contact between fibers. Consequently, wool nano-functionalization can be engineered to enhance the felting properties or prevent undesirable fabric shrinkage during the dyeing and finishing procedures.

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