Structural and Physical Properties of Cotton Fabric used for the Patient Clothing Material through Chitosan/Nanosilver Colloidal Solution Treatment

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1. INTRODUCTION

Patient clothing needs to be laundered frequently, fabric with outstanding durability that is not deteriorated by laundering or chemicals, and no reduction in size and wrinkles following laundering must be chosen[1]. Moreover, tactile sensation and performance improvement are very important as patient clothing must not restrict the movement of the body since it comes in direct contact with the skin, and this is affected in accordance with the structural and physical properties of the fabric.

Chitosan has outstanding bio-degradability and bio-compatibility without inducing environmental pollution. It has composite functions including antimicrobial, deodorization and moisturizing effect[2,3]. Efficiency of treatment, from the economic perspective, can be expected by mixing silver that can provide additional functionality with almost no toxicity to the human body, in order to supplement the weaknesses of chitosan as well as to efficiently elevate the treatment effect[4].

In this research, fabric was treated by using admixture of chitosan, which is a natural macromolecule with excellent bio-compatibility, and nanosilver colloidal solution for which improvement of additional capabilities can be expected while supplementing weaknesses of chitosan, as treatment agent, in order to improve performances of cotton fabric actually used for patient clothing and to perform functional treatment with considerations for effect and economic perspective of treatment. Changes in the structural and physical properties according to the admixture ratio of chitosan/nanosilver colloidal solution were reviewed and compared with the performances of fabric treated only with chitosan.

2. EXPERIMENTAL

The solution of chitosan(CH) and nanosilver(NS) colloid were mixed in the ratios of 3:1(CH3/NS1), 1:1(CH1/NS1), and 1:3(CH1/NS3), and the fabrics treated with them were compared with the fabric treated only with chitosan(CH4). Surface structure of the treated fabric was examined by SEM. The treated fabric was dyed with acidic dye to verify cationization. Refined C. I. Acid Red 88 was used as acidic dye. Dye fastness on the surface of treated fabric was evaluated with *K/S* value. In order to verify internal crystalline structure of the treated fabric, X-ray diffraction pattern was reviewed. In addition, thermal analysis was carried out under stream of nitrogen up to 450℃. Physical properties of the treated fabric were evaluted by whiteness index, tensile strength, stiffness, wrinkle recovery and the changes in performance were also investigated.

3. RESULTS AND DISCUSSION

As cellulose fiber and acid dye, which is an anionic dye, have negative electric charges in aqueous solution, it is seldom dyed due to mutual repulsion. However, the surface electric charge changes due to introduction of cationic amine through chitosan treatment and fabric can be dyed by acid dye and electrical attraction. Therefore, dyeability with acid dye was examined in order to verify cationization of chitosan treated fabric.

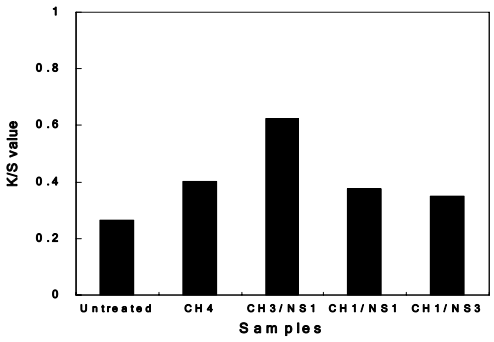

Fig. 1. Effect of K/S value of the fabrics treated with chitosan/nanosilver colloidal solution.

<Fig. 1> illustrates the values of *K/S* obtained by measuring surface reflection ratio of fabric dyed with acid dye. In overall, the values of *K/S* were almost low. This is a result similar to that observed in SEM

and due to usage of low concentration of chitosan/nanosilver colloidal solution.

<Fig. 2> was shown the Tensile strength of chitosan/nanosilver colloidal solution treated fabric improved in comparison to non-treated fabric, which is thought to be the result of hindrance movement of fibers due to treatment with chitosan/nanosilver, thereby preventing fabric from being stretched easily, coinciding with findings in preceding researches. And the fabric treated only with chitosan became stiffer in comparison to the untreated fabric. Treatment of the fabric with admixture of chitosan and nanosilver solution results in greater wrinkle recovery effect than treatment using only chitosan.

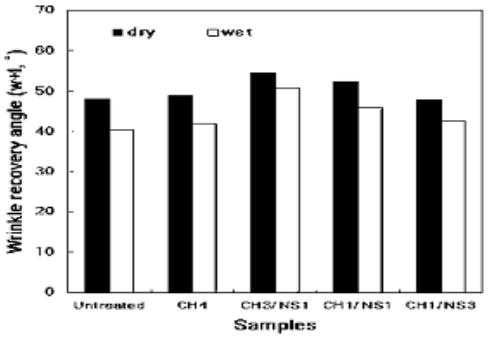

Fig. 2. Effect of chitosan/nanosilver treatment on wrinkle recovery angle of the fabrics.

According to Table 1, all the shrinkage ratios were lowered when treated with chitosan/nanosilver admixture solution with greater reduction in shrinkage ratio with higher ratio of nanosilver colloid.

Table 1. Changes in performance of the fabrics treated with chitosan/nanosilver colloidal solution

Properties	Shrinkage(%)		Pilling (ranking)	Abrasion resistance(cycles)
	Warp	Weft		
Untreated	-2	-2.4	4.5	>20000
CH4	-1.5	-0.5	4	>20000
CH3/NS1	-1.5	-0.5	4.5	>20000
CH1/NS1	-1	-0.5	4.5	>20000
CH1/NS3	-1	-0.5	4.5	>20000

Chitosan/nanosilver colloidal solution treated fabric displayed almost no reduction in pilling of the fabric in comparison to non-treated fabric. However, fabric treated only with chitosan displayed slight reduction in pilling of the fabric, which was recovered when treated again with nanosilver admixture solution. Abrasion resistance of all fabric was not reduced by treatment with processing agent regardless admixture ratio of chitosan/nanosilver colloidal solution. Although treatment process with chitosan/nanosilver admixture solution undergoes swelling under water and thermal processing at high temperature, abrasion resistance was not reduced at all. Accordingly, durability of cotton fabric, which is actual patient clothing material, used in this research was good in general.

4. CONCLUSIONS

Cotton fabric that is actually used as patient clothing material was treated with chitosan/nanosilver colloidal solution in order to improve its functionality. The results of examination are as follows.

1. With regards to surface structure of chitosan/nanosilver colloidal solution treated fabric, add-on ratio increased with increase in admixture ratio of nanosilver. When dyeing the fabric with acid dye to indirectly verify cationization arising from adhesion of chitosan, the chrominance was the largest when the admixture solution ratio was 3:1.

2. Whiteness of the treated fabric was not reduced. Dry strength increased with higher ratio of chitosan, while the wet strength increased the most when the nanosilver admixture ratio was 3:1. All the strengths measured during humidification were larger than during dehydration. Although fabric became stiffer when treated only with chitosan, fabric became softer with increase in nanosilver admixture ratio. Both dry wrinkle recovery angle and wet wrinkle recovery angle were improved.

3. Configuration stability improved with greater reduction in ration of dimensional changes of treated fabric with higher admixture ratio of nanosilver. Pilling of admixture solution treated fabric was superior in comparison to fabric treated only with chitosan. Furthermore, admixture solution treated fabric did not display reduction in abrasion resistance, thereby illustrating physical property of excellent durability of treated fabric to be used as patient clothing material.

5. REFERENCES

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