Synthesis of Waterborne Polyurethane with Mixed Polyols and Its application to Friction-free Processing of the Nylon Black Suede Fabric

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1. INTRODUCTION

The nylon micro-fiber non-woven fabric has been used in various purposes in artificial leather, automobile interior materials, disposable hand towel and others. They have much lower fineness than ordinary textiles for sleek fiber surface, and since the surface area of the textile is broad, it requires much more dyes than that of the fiber with ordinary fineness in order to obtain colors of high density, and because of this, unsatisfactory fastness is often shown.

In addition, the nylon micro-fiber non-woven fabric is used after going through the processing like sanding or pile raising to maximize the micro-fiber effect, and due to the generated mow, the surface friction coefficient of the final product increases and the durability on friction declines. Therefore, there is a need of improvement of durability on friction.

In this study, Waterborne polyurethanes (WPUs) based on isophorone diisocyanate and mixed polyols of poly(tetramethylene glycol) (PTMG) /polycarbo - nate diol (PCD) were synthesized. The synthesized WPU solutions were used as friction-free processing agent for the production of Nylon artificial leathers. The specific characteristic of PU depends upon the structure of hard segment and soft segment which shows the phase separation. Due to its features, PU resins have been generally used as friction-free processing agent for the artificial leather[1].

The treatment resulted that the prepared WPU resins improved the color fastness to washing, rubbing, and light of the artificial leather fabrics, and the improve -ment was greater in increasing PC content within the WPU resin.

In this study, the WPU resin for artificial leather that is used of the polycarbonate (PC) diol as the polyol that improved the mechanical properties of abrasion resistance and others has been applied to solve the problem in declining friction coloration of the nylon micro-fiber non-woven fabric.

2. EXPERIMENTAL

2.1. Materials

Soft segments are polycarbonate diol (PCD) (molecular weight of 2,000 g/mol) and polytetramethylene glycol (PTMG) (molecular weight of 2,000 g/mol), supplied by Asahi Kasei Co. and Dupont respectively. Isophorone diisocyanate (IPDI, Bayer) was used as a hard segment. DMPA, TEA and EDA were also used for syntheses of WPU.

2.2. Synthesis of WPU

PCD, PTMG and DMBA were weighed and placed in a four-necked flask reactor, which was heated up to 120°C with stirring. When DMBA was completely dissolved, the reactor was cooled down to 70°C, and IPDI was input into the reactor. When the reaction reached theoretical -NCO content, the reactor was cooled down to 60°C and TEA was added to the reactor as a neutralizer for 40 minutes. Distilled water was added into prepolymers, and the dispersion process continued for one hour. After EDA was input into the reactor, the chain extend reaction was proceeded, and WPU was completely synthesized.

2.3. Information of the used nylon black suede fabric

- 310g/m^2 spunbond non-woven fabric : sea island ratio of 3:7, fineness after the elution of 0.06den. (D. W. Int. Co.)
- Sanding processing information

Sand paper mesh	Rolling direction	Speed (m/min)
320×400×400×500	right×right×right×reverse	15

- Dyeing: Lanaset Black B (HUNSMAN Co.) 18% o.w.f., 103℃ × 60 minutes, L value of 12

2.4. Friction-free processing

The surface processing was made for each contents of water dispersion polyurethane synthesized on the

fabric of the above information as follows, and when PCD is 100%, the surface processing was made for each solution density. The friction coloration after the processing was analyzed by using the AATCC 8 method.

3. RESULT and DISCUSSION

Waterborne Polyurethanes were prepared by using a two-step bulk polymerization procedure. The prepolymer (attached with —NCO at both ends) was prepared from IPDI, PCD and PTMG until it reached theoretical —NCO content. At synthesizing stage of the prepolymer, the molecular weight increased as the reaction proceeded, and the coefficient of viscosity also increased proportionally. In this case, the time of reaching theoretical —NCO content can be ascertained through the DBA back titration. From this result, appropriate synthetic time with the viscosity of prepolymer was carried out.

WPU that contains the synthesized PC in this study had excellent abrasion resistance that, in the test of using the same as the surface processing agent for micro-suede, it prevented the stain on the friction part contacted to outside from the residue dye on the textile surface to render appropriate durability on the products, such as, artificial leather for clothing, artificial leather for furniture and others. In addition, it is applied as the processing agent to the final set processing without additional processing that the on-site accessibility is outstanding.

As contents of PC increases, the friction coloration was improved and when the PC content is 100%, it displayed the fried friction of grade 3-4 and the acid perspiration friction displayed grade 2-3 (see Table 1).

Table 1. Friction coloration of the WPU (various PCD content %)

PCD content %		0	20	40	60	80	100	Ref.
Friction coloration	Dry	3	3	3	3-4	3-4	3-4	3
	Acid perspiration	1-2	1-2	2	2	2	2-3	1

The WPU-PC100 used the resin for surface processing gave the most outstanding acid perspiration friction fastness to the nylon micro-fiber non-woven fabric, and the result was shown on Table 2. The friction characteristics of the dry fabric was to improve finitely in accordance with the increase of concentration, and the acid perspiration friction fastness was confirmed as shown grade 3 or higher at the resin concentration of 7% o.w.s. or more to a least. However, as undertaking the repeated test of 5 times or more, the acid perspiration friction fastness of grade 3 or higher cannot be guaranteed at all times at the resin concentration of 7% o.w.s. or more, and outstanding and stable friction coloration result of the dry friction of grade 4 and the acid perspiration friction fastness of grade 3-4 or higher can be obtained at the resin density of 10% o.w.s. or more.

Table 2. Friction coloration of the nylon black suede fabric

No.	Conc.(o.w.s.)		3	5	7	10	20	Ref.
1	Friction coloration	Dry	3-4	3-4	3-4	4	4	3
		Acid perspiration	2	2-3	2-3	3-4	4	1
2	Friction coloration	Dry	3-4	3-4	3-4	4	4	3
		Acid perspiration	2	2-3	3	4	4	1
3	Friction coloration	Dry	3-4	3-4	3-4	4	4-5	3
		Acid perspiration	2-3	2-3	3	3-4	4	1
4	Friction coloration	Dry	3-4	3-4	3-4	4	4	3
		Acid perspiration	2	2-3	3	3-4	4	1
5	Friction coloration	Dry	3-4	3-4	4	4	4-5	3
		Acid perspiration	2	3	2-3	4	4	1

4. CONCLUSION

The artificial leather for clothing, furniture and others stimulate friction through frequent contact with the skin, and because of this, the dye on the textile surface drops off on the contact part that stable fastness is very important.

As the content of WPU-PC100 increases, the characteristics of friction resistance gets more outstanding, but as the contents and concentration of the PC increase, Hand value on surface processed fabric is increased with the stiff. This type of sense is subjective opinion to present detailed figures, but as a result of expert making the comparison in the aspect of functionality and sensitivity for fabrics processed in several concentrations of WPU resin, it is determined as appropriate with the 100% PC contents of and concentration of 10% o.w.s.

5. References

[1] Y. N. Osin, L. Y. Makhotkina, L. N. Abutalipova, and I. S. Abdullin Agarwal; *Vacuum*, 51, 221-243(1998).