한국섬유공학회 학술발표회 논문집, 제 36 권 제 1 호

초음파 라미네이트 부직포의 형태구조와 강도특성에 처리조건의 영향

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Effect of Processing Conditions on the Morphological Structure and Strength Properties of Ultrasonically Laminated Nonwovens

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1. Introduction

There are three major bonding types such as chemical bonding, thermal bonding, mechanical bonding to produce nonwoven fabrics. The development of the past few years has shown that the share of thermally bonded webs is growing steadily. The viability of the thermal bonding process is rooted in the price advantage obtained by lower energy costs. However, the thermal bonding process also obtains the quality requirements of the market place. Ultrasonic bonding process involves the application of rapidly alternating compressive forces to localized areas of fibers in the web. The frictional force created by these compressive forces is converted to thermal energy, which softens the fibers as they are pressed against each other. Upon removal from the source of ultrasonic vibration, the softened fibers are solidified the bond points. This method is frequently used for spot or patterned bonding of fibrous materials. Fabrics produced by ultrasonic technique are soft, breathable, absorbent and strong. This bonding method is used to make patterned composites and laminates, such as quilts and outdoor jackets. Thus, in this study we investigated the morphological structures and the bonding strengths of ultrasonic bonded nonwovens with different processing conditions.

2. Experimental

2.1 Preparation of sample

Figure 1 shows the schematic diagram of ultrasonic bonding apparatus to produce samples. The prepared nonwovens were passed by ultrasonic machine with different applied pressure and feed speed. Two kinds of nonwovens were used. i.e., CASE(A) was polyprophylene needle punched nonwovens(160GSM) and CASE(B) was laminated with polyprophylene needle punched nonwovens(160GSM) and meltblown nonwovens(60GSM). Table 1 shows processing conditions to make samples. The used frequency was constant with 20kHz. On the other hand, to observe the bonding force, we change the pressure from 0.3 to 0.5Mpa with 0.1Mpa interval and the applied feed speed was 6, 8 and 10m/min.

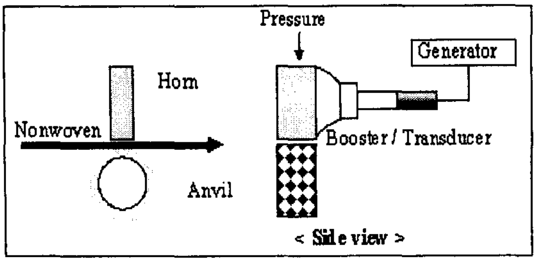


Figure 1. Ultrasonic bonding system.

Table 1. Processing conditions of making CASE(A) and CASE(B) samples.

Pressure (Mpa) \ Feed speed (m/min)	6	8	10
0.3	①	②	③
0.4	④	⑤	⑥
0.5	⑦	⑧	⑨

2.2 Morphological structure

To observe the morphological structure of bonding region with different treatment pressure and feed speed rate, we used SEM(S-2350, Hitachi).

2.3 Tensile properties

To estimate tensile force and debonding force at bonded point in the PP(NP, 160GSM) nonwovens and the laminated PP(NP, 160GSM)/PP(MB, 60GSM) nonwovens were measured by tensile tester(Instron 4467). The tensile and debonding experiments were carried out two different methods. Figure 2 shows experimental diagram of tensile and debonding testing. **a** is untreated material, **b** and **c** are the ultrasonically treated materials. The sample size was 1㎝×6㎝ having three bonded point. Crosshead speed was 100㎜/min and used load cell 50kgf. Sample **c** has ten bonded point structure. Crosshead speed was 30㎜/min as slow as possible with 5kgf of load cell.

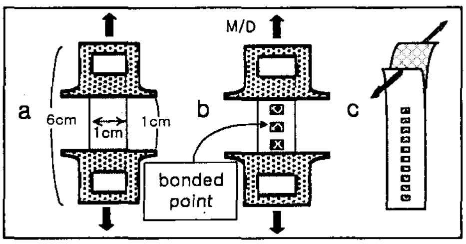


Figure 2. Schematic diagram of tensile testing.

3. Results and discussion

3.1 Morphological structure

Figure 3 shows the morphological structure of the bonded point for CASE(A) and cross-sectional view of CASE(B). As the pressure is increased and feed speed decreased, the bonded region was broaden. The processing condition of CASE(B)(pressure: 0.3Mpa, speed: 10m/min) produced the lowest degree of bonding as is evident in presence of unbonded individual fibers in the microphotograph. Meanwhile the processing condition of CASE(B)(pressure: 0.5Mpa, speed: 6m/min) shows the highest degree of bonding as is obvious from middle part of the cross-section where there are very few individual fibers.

CASE(A)

① ④ ⑦ ⑧ ⑨

CASE(B)

① ④ ⑦ ⑤ ⑥

Figure 3. SEM microphotographics of the bonding area of CASE(A) and cross-section of CASE(B) with different pressure and feed speed.

3.2 Tensile properties

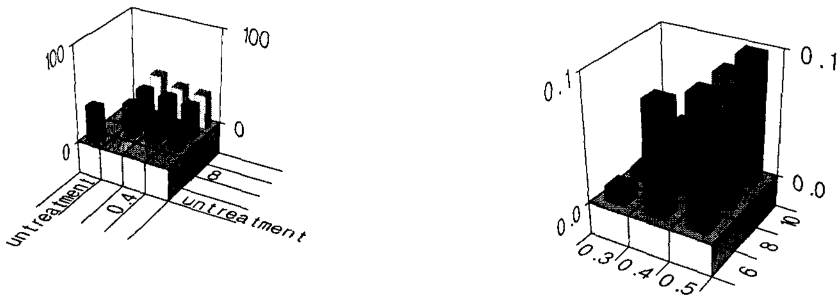
Table 2 and 3 shows the tensile properties and debonding properties of the bonded points for CASE(A) and CASE(B), respectively. The breaking force of untreated sample was 36.2kgf/g in CASE(A). The breaking force of processing condition(pressure: 0.3Mpa, speed: 8, 10m/min) was higher than untreated value. Because the individual fibers of the pointed bonded regions in this conditions melted the strong and thick film shape. But other conditions have lower breaking force. Because breaking is happened at the weak point of point bonded edge region. In the CASE(A) produced under the pressure of 0.5Mpa and the speed of 6m/min had the lowest maximum breaking force and CASE(A) produced at the pressure of 0.3Mpa and the speed of 10m/min had the highest. The maximum force at the breaking point decreased with the decrease in the feed speed and increased in pressure. In the CASE(B), as the pressure is increased and the feed speed is decreased, the maximum debonding force was increased.

Table 2. Tensile properties with different setting of CASE(A). (unit: kgf/g)

Feed speed (m/min) / Pressure (Mpa)	6	8	10
0.3	33.46	37.81	43.30
0.4	28.78	36.72	36.17
0.5	26.02	33.92	35.26

Table 3. Debonding properties with different setting of CASE(B). (unit: kgf)

Feed speed (m/min) / Pressure (Mpa)	6	8	10
0.3	0.018	0.015	0.013
0.4	0.13	0.08	0.06
0.5	0.15	0.15	0.15



CASE(A) **CASE(B)**

Figure 4. Graph for different setting of CASE(A) and CASE(B).

4. Conclusion

Both CASE(A) and CASE(B), when applied pressure increased and feed speed decreased bonding region was broaden and debonding force of CASE(B) was increased. But, tensile force of CASE(A) was decreased. The reason was that the high bonding degree made the wide bonding region of nonwoven with weak point of edge. And the breaking force under the condition(pressure 0.3Mpa, speed: 8, 10m/min) was higher than untreated condition. When it set the pressure o 0.4Mpa and speed of 6m/min, the maximum load of debonding properties was 0.13kgf. But th setting of pressure of 0.5Mpa and speed of 6m/min occurred tearing of PP(MB, 30GSM). This phenomena is due to perfect bonding. This experiment can be improved with the consideration of the change of nonwovens properties and processing conditions.

***Acknowledgement**: This study was supported by Dongwon Roll Co. Funds.

5. References

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