Tensile Characterization of Spot Bonded Spunbond(SBS) Nonwovens

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1. INTRODUCTION

Spunbond nonwoven fabrics can be achieved by using heat in a variety of ways and by needling treatment. The method of thermal bonding and the fiber type ultimately influence the mechanical properties of the resultant nonwovens. Webs consisting of fibers with having low melting points, such as polypropylene, can be thermally bonded by direct heating via a hot calender, through air, ultrasonic or microwave. These processing conditions have influenced on the physical and mechanical properties of nonwoven fabrics. To obtain the optimum strength properties at the spot bonded spunbond(SBS) nonwovens, the fiber should continue to display a web structure. That means the bonding points have not completely melted at the melting temperature of the fiber material has been melted on the surface.(1-4)

The structure parameters of the fabric which can be affected by the manufacturing process includes geometrical arrangement of the fibers and bond points as well as the size and distribution of the bond points within the sample. The structure of SBS nonwovens can significantly effect fabric properties as well as fabric failure mechanisms(5-7). Therefore, We have investigated morphological structure and the effect of gauge length, tensile angle, strain rate on the mechanical properties of spot bonded spunbond SBS nonwovens made from the polypropylene filament.

2. EXPERIMENTAL

The sample used in this study was two types of the SBS nonwovens produced by polypropylene and the nonwoven structure consists of regular square shaped spot pattern by using thermal bonding method. The samples have a lattice of discrete spot bonds connecting unbonded fibers and are classified according to their basic weight and thickness(Table. 1).

Table. 1 Sample characterization

Sample ID	Thickness(mm)	Basic weight(g/m^2)
A	1.9	80.9
B	1.4	53.2

The basic weight and thickness were measured with an electronic balance and a thickness gauge according to ASTM D3770 and ASTM D1777, respectively. The samples were cut with different form of the fabric angle(θ) to the machine direction such that θ=0°, 30°, 60°, 90° and cut into 13mm in width and four levels of 9, 18, 27, 36mm in length. The tensile properties such as breaking stress, breaking strain and initial modulus were measured on an Instron tensile tester with load cell 50kgf, and strain rate 10, 20, 30, 50, 100mm/min. In order to observe the surface and cross-section structure of samples, SEM and optical microscopy was used

3. RESULTS AND DISCUSSION

3.1 Morphological Structure

Microphotographs of SBS nonwovens presented in Fig. 1 is appeared surface structure of bond region. In the bond region, polypropylene filaments are showed not perfectly melted. Microphotographs of tensile failure on tensile time of the SBS nonwovens are shown in Fig. 2. Tensile failure of SBS nonwovens is showed not failure in bond region but pull out polypropylene filament in that.

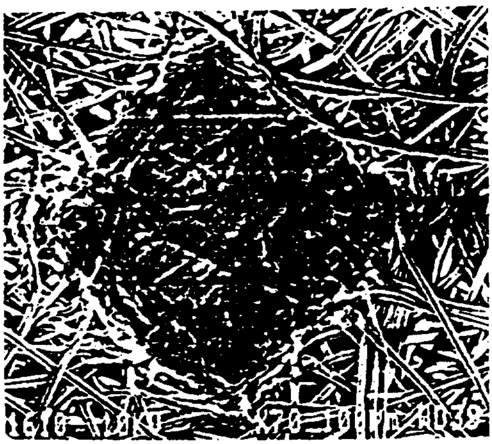

Fig. 1 Surface Structure of SBS nonwovens.

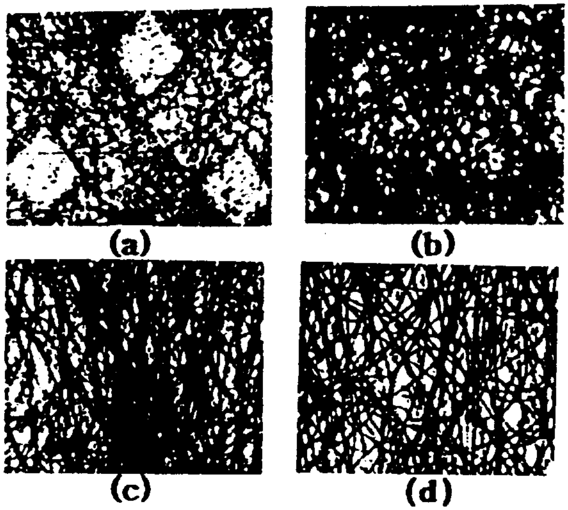

Fig. 2 Microphotographs of the tensile failure behavior of SBS nonwovens. (magnification : ×40, gauge length : 9mm, interval : 3sec)

3.2 Effect of strain rate, gauge length and tensile angle

The results of strain rate's effect on the breaking stress of SBS nonwovens are shown in Fig. 3. The breaking stress of SBS nonwovens has increased with increasing the strain rate. Fig. 4 shows the relationship between gauge length and initial modulus of SBS nonwovens with different tensile angles. The initial modulus of samples have an slightly increasing trend with increasing gauge length and with decreasing tensile angles which indicate toward machine direction.

For the different tensile angle of SBS nonwovens, polar diagram is shown in Fig. 5. The breaking stress in machine direction(0°) was stronger than that of cross direction(90°). It is considered that fiber orientation distribution of machine direction is better than that of cross direction.

Fig. 6 shows the relationship between tensile angle and breaking strain of the SBS

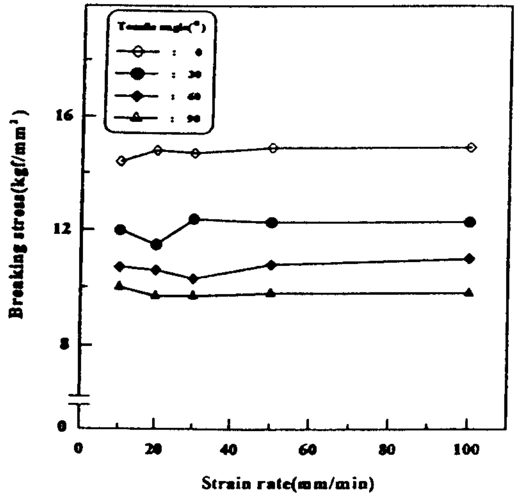

Fig. 3 Effect of strain rate on breaking stress of SBS nonwovens.

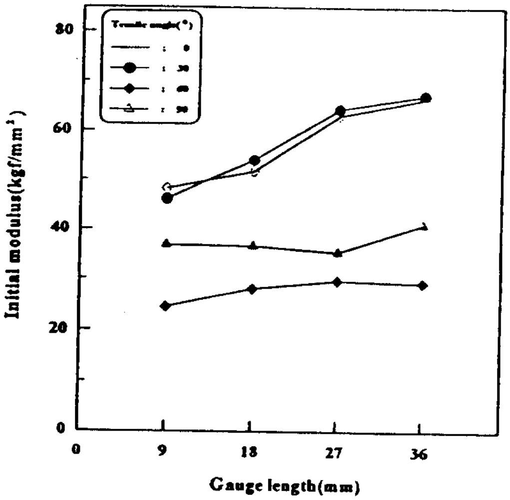

Fig. 4 Relationship between gauge length and initial modulus of SBS nonwovens.

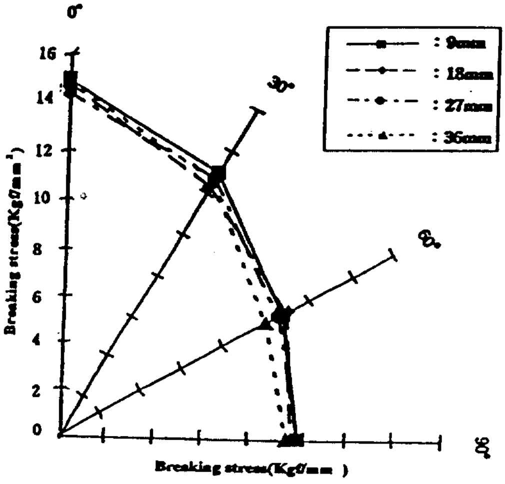

Fig. 5 Polar diagram of tensile angle on breaking stress of SBS nonwovens.

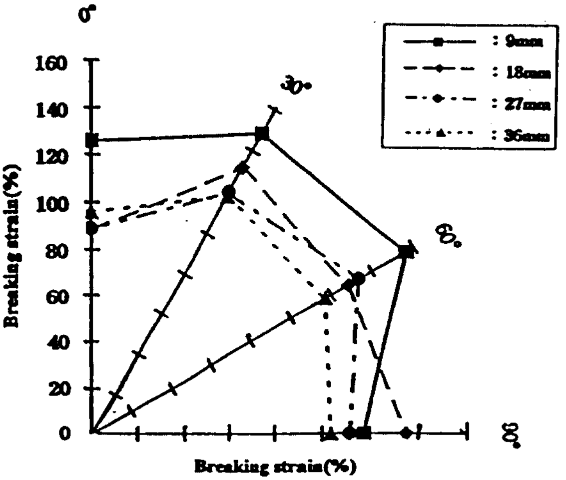

Fig. 6 Polar diagram of tensile angle on breaking strain of SBS nonwovens.

nonwovens as a polar diagram. The breaking strain of SBS nonwovens with tensile angle 60° was appeared maximum value rather than tensile angle 90° and the gauge length effect has a decreasing in the breaking strain of SBS nonwovens.

4. CONCLUSION

We have investigated the effect of tensile angle, strain rate and gauge length on the tensile properties of SBS nonwovens made from polypropylene filament. The results obtained in this study are as follows :

1) Polypropylene filaments in the bond region is not perfectly melted and the filaments were individually separated under tensile loading,
2) The breaking stress has increased with increasing the strain rate, but gauge length effect has an opposite trend. and
3) The fiber arrangement of SBS nonwovens is more orientation toward machine direction rather than toward cross direction from the results of tensile properties on SBS nonwovens.

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