형상기억효과를 가지는 전기방사된 폴리우레탄 부직포에 관한 연구

차동일, 김학용, 정용채*, 조재환*, 전병철**, 정용찬†
전북대학교 섬유공학과, *건국대학교 섬유공학과, **수원대학교 고분자공학과, † 수원대학교 화학과

Electrospinning of Polyurethane Block Copolymers with Shape Memory Effect

Dong-Il Cha, Hak-Yong Kim, Yong-Chae Jung*, Jae-Whan Cho*, Byoung-Chul Chun, and Yong-Chan Jung†**

Department of Textile Engineering, Chonbuk National University, Chonju, Korea
**Department of Textile Engineering, Konkuk University, Seoul, Korea*
***Department of Polymer Engineering, The University of Suwon, Suwon, Korea*
† Department of Chemistry, The University of Suwon, Suwon, Korea

1. Introduction

Shape memory polyurethane (PU) with soft and hard segments has been extensively researched since its discovery by Mitsubishi in 1988 [1]. Hard segments can be formed via hydrogen bonding and crystallization, function as physical crosslinks below melting point (Tm). The reversible phase transformation of the soft segment is responsible for the shape memory effect.

Recently, interest in electrospinning has been rapidly increased because the polymer fibers produced by this method have a sub-mircon diameter, and these are of considerable value to a wide variety of applications, such as filtration, reinforcement in composites, biomedical devices, etc. Electrospinning has been broadly reported since its patent by Formhals in 1934.

In this study, the electrospinning of the shape memory PU block copolymers with various hard segment ratios was investigate, and characterized their physical and mechanical properties.

2. Experiment

2.1. Solution Properties

Viscosity of PU was measured with a rheometer (DV Ⅲ, Brookfield Co., USA), using spindle No. 3 at 100 rpm at room temperature. Electric conductivity was measured with an electric conductivity meter (G series, CM-40G, TOA Electrics Ltd., Japan).

2.2. Electrospinning

The PU block copolymers solution, prepared in a mixed solvent of THF and DMF (30, 40, 50 wt%), was kept in a 5 ml syringe and attached with a capillary tip of about 1 mm in diameter. A cathod was attached to a grounded rotating collector. The electric field was supplied by a high voltage power supply (CPS-60 K02v1, Chungpa EMT, Co., Korea), which is capable of generating

voltage up to 50 kV.

2.3. Thermomechanical Properties

To check the shape memory effect of the electrospun PU mats, the relationship between stress and strain at various temperatures was analyzed by a UTM equipped with a controlled thermal chamber.

3. Results and Discussion

Electrospinning has many parameters such as solution properties, controlled variables, and ambient conditions. One of these, solution properties, which involves polymer concentration, viscosity, surface tension, and electric conductivity, etc. depends on the polymer and the solvent. The concentration, viscosity and electric conductivity of the solutions for various PU are shown in Table 1.

Table 1. Solution properties

Hard segment ratio (wt%)	Solution concentration (wt%)	Viscosity (cPs)	Electric conductivity (mS/m)
30	36	580	0.039
	40	-	-
40	26	137	0.079
	30	570	0.040
50	30	175	0.080
	38	530	0.052

The maximum tensile stress and shape recovery of electrospun PU block copolymers nonwoven with 40 and 50 wt% of hard segment are shown in Fig. 1. Shape recovery was not observed at 30 wt% of hard segment, however, because the significantly available mat couldnt be prepared under this spinning condition at 30 wt%. The maximum stress at 40 wt% of hard segment had a value 2 times greater in comparison with that at 50 wt% of hard segment.

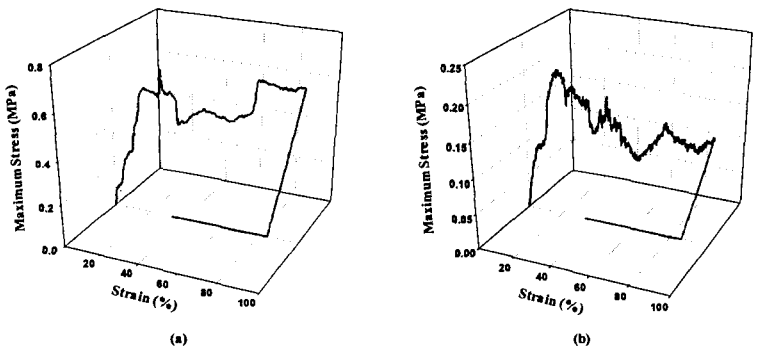

Figure 1. The maximum stress and shape recovery of electrospun PU block copolymer mats; (a) 40 wt%, (b) 50 wt% of hard segment content.

4. Reference

(1) Richard, F.; Gordon, P. E. *Mater. Technol.* **1993**, 8, 254.