Study on the Draw Resonance of Melt Spinning of Polypropylene/ Polyethylene Blends

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In the melt spinning process, quality and productivity of fibers are restricted by a preiodic variation in fiber diameter during spinning, that is, the draw resonance due to the flow instability. Therefore, lots of studies have been carried out for the causes of draw resonance but very few papers were published for the traw resonance of the blend fibers.

In this study, investigation was made for the effect of draw ratio and blend ratio on the draw resonance of the polypropylene (PP) and Polyethylene (PE) blend fibers, where PP has the high tendency of draw resonance and PE has low.

Chips of PP and PE were melt blended by the twin screw blender in various blend ratios and two homopolymers. The blend chips were then melt spun in the lab melt spinning machine at various draw ratios from 10 to 160.

From the experimental results, it can be conculeded that the D_{max}/D_{min} ratio increases as the draw ratio increases for each blend fibers and the critical draw ratio increases and D_{max}/D_{min} decreases as the PE content in the blend fibers increases.

1.INTRODUCTION

Development in polymer science has been achieved by various researches in the field of chemistry and due to the concept of better understanding of polymers by physical blending, many researches have been carried out.

Although polypropylene (PP) and polyethylene (PE) blends have been known to be incompatible [Plochocki, 1966; Robertson and Paul, 1973], to enhance the processability, impact strength and environmental stress cracking resistance of the (PE) blends, investigations have been carried out.

After the draw resonance was first observed by Miller [Miller, 1963], its special features have been investigated by many polymer scientist and engineers. Draw resonance is the phenomenon in which the cross-sectional area of the fibers (extrudates) varies periodically. This phenomenon can be disclosed physically by the heat effect [Bergonzoni and Dicresce, 1966], elasticity [Han and Kim, 1976], and kinematic wave theory [Hyun, 1978]. Theoretical [Pearson and Shah, 1974] and experimental [Chang and Denn, 1979] investigations also have been carried out.

For the blends, studies on the instability of the low density (LD) PE/PP, high density polyethylene (HDPE), Polybutene-1 (PB) blends [Santamaria and White, 1986] and the draw resonance of the blend of PP with 20 % LDPE [Yoo, 1987] have been carried out.

PE is known to be elongational thickening and non-draw resonant material, but PP is elongational thinning and easily draw resonant material.

In this paper, study has been done to observe the draw resonance behavior of the PP/PE blends. Therefore, by varying the blend ratios. D_{max}/D_{min} ratio (Dmax and Dmin: max. and min. diameters of the blend fibers, respectively), the periods and the slope of the draw resonance were measured and calculated, and discussed with ratios and draw ratios.

2.EXPERIMENTAL

2.1.Material

Polymer materials used for this experiment are LDPE produced by Hanyang Chemical Co.Ltd.and the isotactic PP produced by Dae Han Petrochemical Co.Ltd.

Their specifications are listed in Table 1.

Table 1. Grade and Properties of PP and LDPE
Tablo 1. PP ve LDPE'nin Grade ve Özellikleri

Polymer	Grade	Melt index (g/min)	Dinsity (g/cm^3)	Melting point (°C)	Molecular Weight	
					Mn	Mw
PP	5016H	15.0	0.900	164	36.900	225.000
LDPE	5321	3.0	0.919	104	20.700	150.600

2.2.Blending and Melt Spinning

PP and LDPE were melt mixed at 200 °C in the twin screw extruder at the blend ratio of 100/0, 90/10, 70/30, 50/50, 30/70, 10/90, 0/100 for the PP/LDPE blends and chips made. These chips were then melt spun by the experimental melt spinning machine. Operating conditions are listed in Table 2.

A water quench bath was located at 10 cm below the spinneret to reduce the effect of cooling on the draw resonance.