# 가공조건의 PP/PBT blend의 fibril 구조에 미치는 영향

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# Effect of processing condition on the fibrillar structure of PP/PBT blend

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## 1. Introduction

Polymer blending is one of the popular methods used in developing new materials which have the desired properties because it is the cheapest way in developing new plastics. However, as most polymers are immiscible, immiscible polymer blends form multiphase system with minor phase morphology such as spheres, ellipsoids, fibrils, platelets, and ribbons[1].

The properties of polymer blend strongly depend on the final morphology. It is widely known that the final morphology of blend has a controlling influence on its properties. The final morphology of dispersed phase depend on the properties of the blend component and the processing condition. Microstructure of immiscible polymer blends through deformation and orientation of the dispersed phase is affected by the flow history during the melt processing.

We have observed that PP/PBT blend shows the fibrillar structure of PBT during the extrusion process. In this study, the effect of processing condition (mixing temperature, rotor speed) on the fibrillar structure has been investigated.

## 2. Experiments

PP (MI: 1g/10min) used for this study was supplied by Honam Petrochemical Co. and PBT(Mn: 30,000, Mw: 53,000, Tm: 227℃) was purchased from Sigma-Aldrich Co.. PBT was vacuum-dried at 80℃ for at least 12hours in order to remove moisture.

The melt compounding of PP/PBT blends was performed in a twin screw extruder by changing rpm from 25 to 75 at fixed mixing temperature of 220℃. The extruder barrel is divided into three zones and a die. Mixing temperature varied from 220℃ to 250℃ at fixed rotor speed of 25rpm. Extruded standards were cooled in air condition.

Morphology of molten PP/PBT blend was observed using a Olympus BX51 microscope with 10X lens coupled with a Linkam CSS-450 hot stage. Molten blend was observed at 180℃ which was between $T_m$ of two component. Since PP was fully melted and PBT was not melted at this temperature, polarized light can be used to observe the blend morphology. Because thick layers were highly scattering, turbidity limited the observation of their morphology by optical system. The sample was held in the gap between the two quartz windows. When the sample was melted, the gap was modified to 100㎛.

## 3. Results and Discussion

The fibrillar structure was observed in the PP/PBT blend. The fibrillar morphology of the PBT phase was elaborated in an extrusion at 220℃. Figure 1(a) shows fibrillar structure and a bundle of fibrils. As mixing temperature increases, fibrillar structure disappeared. Figure 1(b) shows less fibrillar structure than in Figure 1(a) and the fibrillar bundles became smaller.

Moreoverx the droplet structures were observed in Figure 1(b). The droplet structures aligned due to shear flow. So it was supposed that the fibrillar structure breaks up into the drop structure. Figure 1(c) and (d), clearly show that phenomenon.

In shear field, viscous drops with p>4 ($p=\eta_d/\eta_m$ : viscosity ratio) never break into droplets. The drop can break up only if p<4 [2-7]. At the mixing temperature above the melting temperature to PBT, the viscosity of PBT becomes very small compared to that of PP. As mixing temperature increases, viscosity of PBT decreases. As a result, the viscosity ratio less than 4 and the fibrillar structure breaks up into the droplet structure.

Figure 2(a) shows many fibrillar structures and bundles. At rotor speed of 50rpm, the bundle of fibrillar structure become thinner than that at 25 rpm. At 75 rpm, bundle of fibrillar structure is hardly observed. Moreover short fibrillar structure is observed. It seems that long fibrillar structure break into short droplet structure.

## 4. Conclusion

PP/PBT blend forms fibrillar structure depending on processing condition. Fibrillar structure breaks up into droplet as mixing temperature increases. At high rotor speed, fibrils were broken. We proposed that mixing temperature near $T_m$ of PBT and low rotor speed could make the fibrillar structure of PP/PBT blend.

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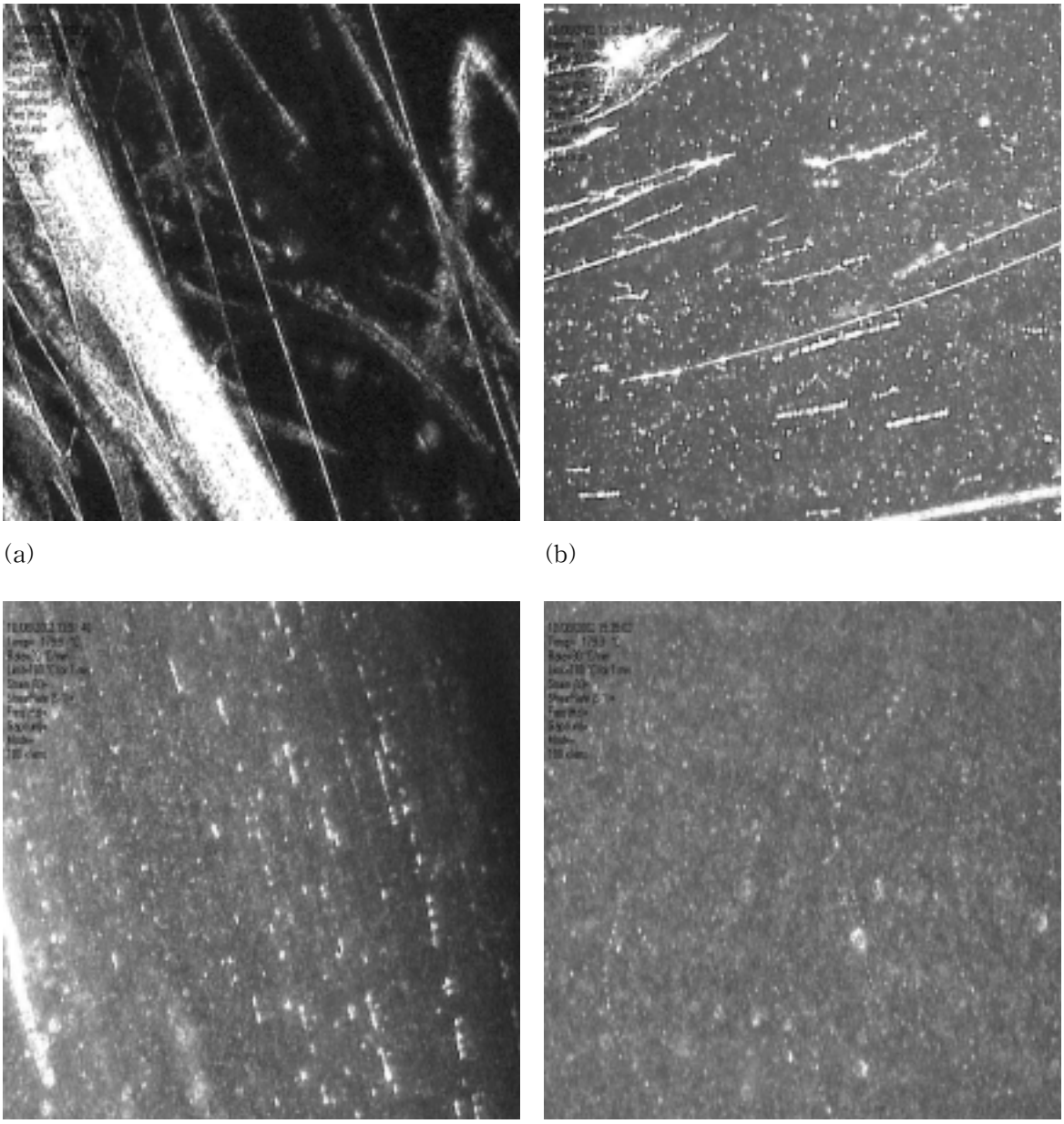
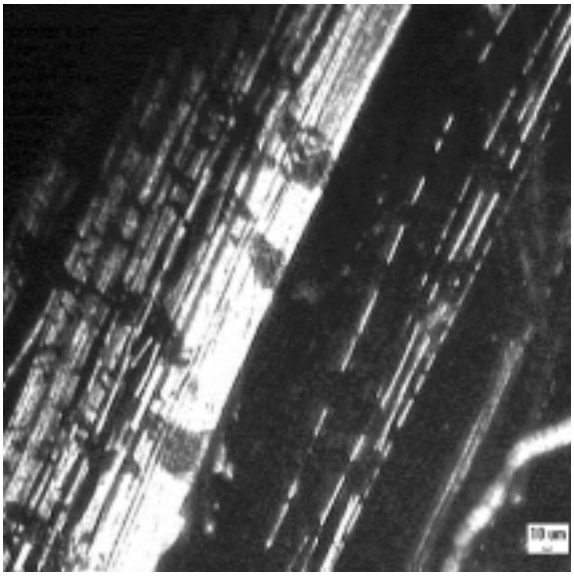


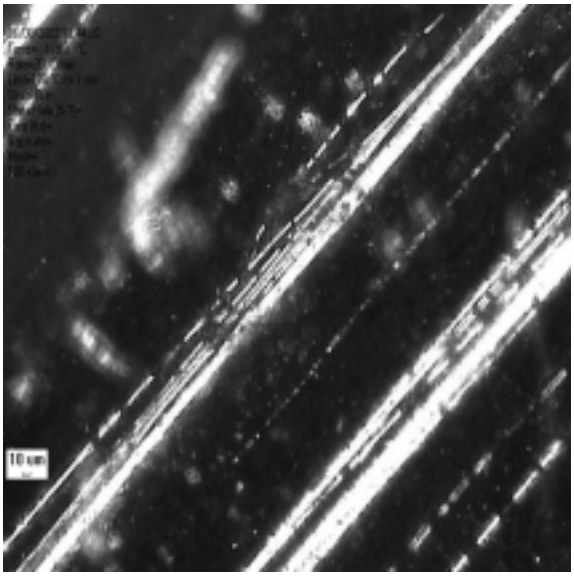
(a) (b)

(c) (d)

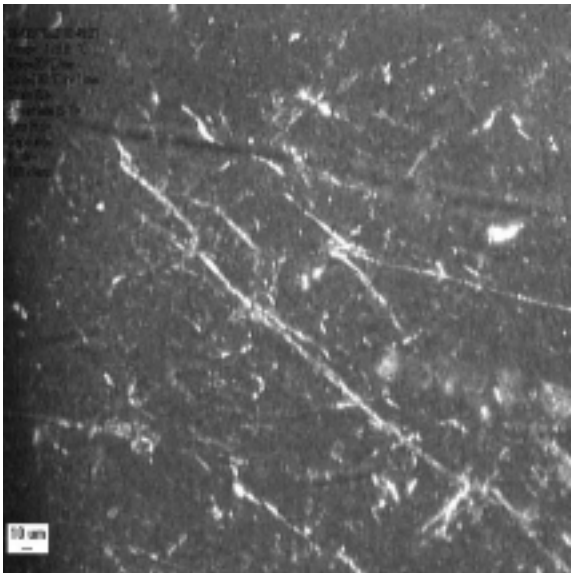
Figure 1. POM(polarized optical microscope) pictures of PP/PBT blend mixed at different mixing temperature; (a) 220℃, (b) 230℃, (c) 240℃, (d) 250℃ (Each compounding was performed at 25rpm).



(a)



(b)



(c)

Figure 2. POM(polarized optical microscope) pictures of PP/PBT blend mixed at different rotor speed; (a) 25rpm, (b) 50rpm, (c) 75rpm (Each compounding was performed at 220℃).