High molecular weight PET/nano-clay 복합체의 유변학적 특성 연구

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Rheological properties of high molecular weight PET/nano-clay composite

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Introduction

In the past decade, clays have been used as reinforcing materials for polymers owing to their high aspect ratio and unique intercalation/exfoliation characteristics. Nanocomposites of polymer/clay can be obtained by direct polymer intercalation where the polymer chains diffuse into the space between the clay galleries[1,2].

The mechanical properties of the products are affected by the degree of exfoliation. Successful melt exfoliation requires the presence of strong interactions between clay and polymer. Once exfoliated, the clay platelets dispersed in the polymer matrix present high stiffness and strength[3,4].

Poly(ethylene terephthalate) (PET) is a semicrystalline thermoplastic polymer with low cost and high performance and has found wide applications in the form of films and fibers.

General-purpose PET/clay nanocomposites have been studied since early 1990s. There are many companies developing the composite having enhanced physical properties, but commercialization is still to come. The major drawbacks in commercialization of the composites are haze of final products, I.V. drop of PET resin and agglomeration of clay particles in PET matrix [5-7].

Little research on the high MW PET/nano-clay composite have been carried out. This study investigates the rheological properties of high MW PET/nano-clay composites.

Experimental

PET of I.V 1.05 (Hyosung) was used as matrix polymer and the loading level of nano-clay pellete tested was 0.3 and 1.0 wt%. Advanced Rheometric Expansion System (ARES

Rheometric Scientific, Inc) was used to measure the rheological properties of the composites. Parallel-plate geometry with 25 mm in diameter was used. The plate gap and strain level were 1 mm and 10%, respectively. Dynamic frequency- sweep measurements were conducted over the angular frequency range of 0.05-500 rad/s at 290, 300, and 310 ℃.

Results and discussion

Figs. 1a, 1b, and 1c show variation of dynamic viscosity(η') of PET/nano-clay composites at (a) 290, (b)300, and (c) 310℃,respectively. It is interesting to see that higher viscosity is observed at 0.3 wt % while lower viscosity is observed at 1.0 wt% in the low-frequency range, which tendency stands out with increasing temperature.

This is ascribed to the fact that plate-shaped clay structure disturbs flowing of fluid at 0.3 wt% but it improves flowability of the composite at 1.0 wt%. In addition, with increasing temperature viscosity falls rapidly as expected.

The frequency-dependence of storage modulus in fig. 2 shows that 1 wt% composite gives rise to a more abrupt decrease of storage modulus increasing tendency with increasing frequency by 10 rad/s.

Plot of loss tangent(tanδ) is a quantitative measure of solid-like elastic body or liquid-like viscous fluid of a system. Fluid character is dominant when the loss tangent value is greater and solid character is dominant when the value is smaller. As shown in fig. 3 fluid character is fainted rapidly at 1.0 wt% while fluid character is dominant at 0.3 wt%. This suggests that the more clay content is, the bigger magnitude of interaction is.

References

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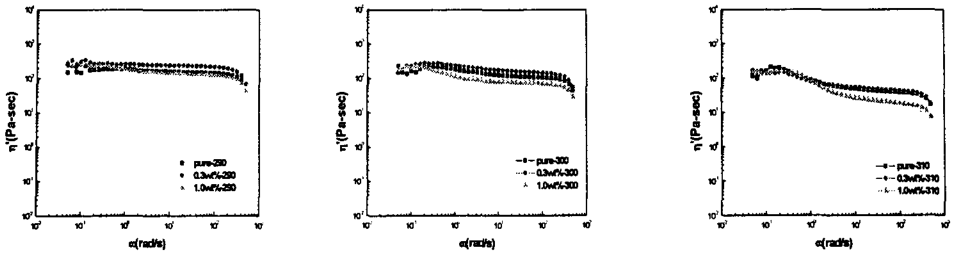
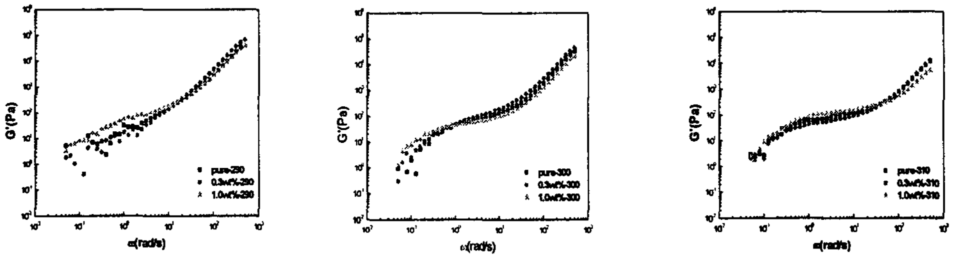


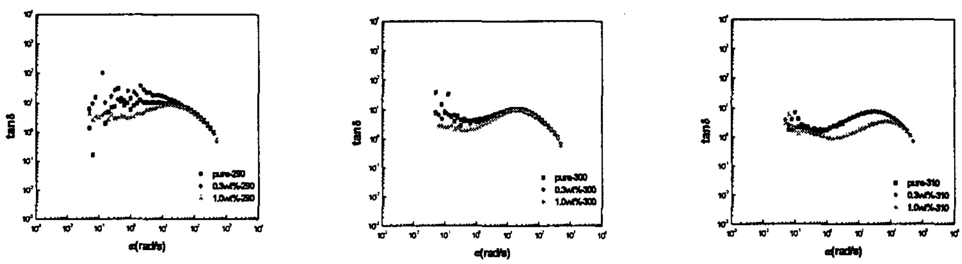
(a) (b) (c)

Fig.1 Dynamic viscosity curve of PET/nano-clay with different clay content at (a) 290 ℃, (b) 300 ℃ (c) 310 ℃



(a) (b) (c)

Fig.2 Storage modulus curve of PET/nano-clay with different clay content at (a) 290 ℃, (b) 300 ℃ (c) 310 ℃



(a) (b) (c)

Fig.3 Loss tangent curve of PET/nano-clay with different clay content at (a) 290 ℃, (b) 300 ℃ (c) 310 ℃