Blends of Liquid Crystalline Polymer and Thermoplastic Matrix Polymer : The Effect of the Viscosity Ratio and Processing Conditions

최 기 대, 조 원 호
서울대학교 공과대학 섬유고분자공학과

INTRODUCTION

The concepts of tailoring polymer properties through blending with other polymers and fillers have long been recognized as a viable method to meet specific applications. In particular, polymer blends containing liquid crystalline polymers (LCP) have been studied intensively to achieve a so-called *in situ* composite structure with oriented LCP fibrils in the thermoplastic matrix.[1-4] When the LCP is a minor component, it is potentially capable of forming highly elongated fibrous structures parallel to the extensional flow direction. The primary factors determining the morphology of the LCP domains in the thermoplastic matrix are the LCP content, processing conditions, and rheological characteristics of the blend components in particular viscosity ratio. In this study, we examined the effect of the viscosity ratio of dispersed phase (LCP) to the thermoplastic matrix (PS/PPO) on the rheological, morphological, and resultant mechanical properties of the blends containing a LCP.

EXPERIMENTAL

The LCP (Vectra B950) is commercial wholly aromatic liquid crystalline copolyester consisting of 20 mol % terephthalic acid, 20 mol % amino phenol, and 60 mol % 2,6-hydroxy naphthoic acid. The thermoplastic matrix polymers used are polystyrene/poly(phenylene oxide) (PS/PPO) blends with different compositions. The LCP blends were prepared in a Brabender laboratory single screw extruder at 300 °C. The rheological properties were measured on a Rheometrics Mechanical Spectrometer (RMS 800) with cone and plate geometry. The cryogenically fractured surface was coated with gold and examined by scanning electron microscope (SEM, JEOL JSM-35). Completely dried blend samples were injection molded using Mini-Max Molder (CS-MMX, Custom Scientific Instruments, Inc.) at 300 °C. Mechanical properties were measured by using an Instron Tensile Tester at room temperature.

RESULTS AND DISCUSSION

The flow curves and the corresponding viscosity ratios (η_{LCP}/η_{matrix}) of PS/PPO blend and pure LCP in the shear flow at 300 °C are shown in Figure 1 The PS/PPO matrix sample exhibits slightly non-Newtonian behavior at the shear rate range examined. The viscosity of PS/PPO is largely dependent on the blend composition, so that different levels of viscosity ratios could be obtained by using a LCP and PS/PPO thermoplastic matrices. Also, the viscosity ratio did not depend only on the blend compositions but also on the shear rate. Figure 2 represent the mechanical properties of

LCP blends as a function LCP content. It is important to note that elastic modulus show a positive deviation from the simple additive rule for the blends of LCP and PS/PPO (7/3), while the blends of LCP and PS/PPO (10/0) follow the simple additive rule. This tells us that the reinforcing effect of LCP becomes more significant when the viscosity of LCP is lower than the thermoplastic matrix polymer. In summary, the viscosity ratio of the dispersed phase to the matrix is an important factor in determining the morphological and mechanical properties of LCP blends.
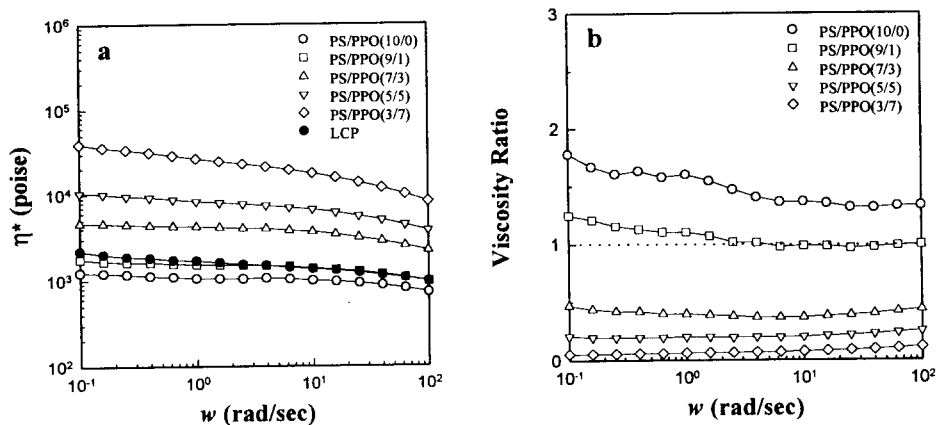

Figure 1. Shear rate dependence of the complex viscosity and the corresponding viscosity ratios (η_{LCP}/η_{matrix}) of PS/PPO blends and LCP at 300 °C.
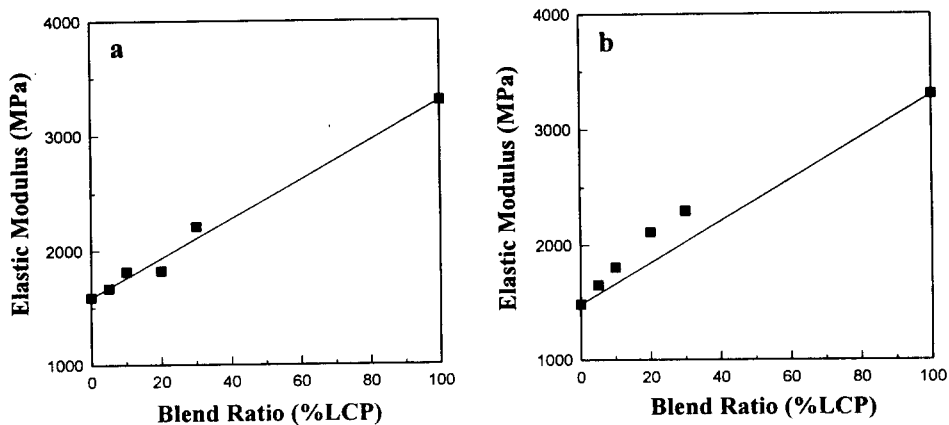

Figure 2. Elastic modulus of the LCP and PS/PPO blends : (a) PS/PPO (10/0), (b) PS/PPO (7/3).

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