Structure and Properties of TLCP/Polyester Composite Fibers

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Abstract

TLCP/polyester composite fibers (TPCFs) based on melt blends of PEN, PET, and TLCP were prepared by melt blending and spinning process to achieve high performance fibers. Reinforcement effect and TLCP fibrillar structure resulted in improvement of mechanical properties for TPCFs. The increase in the apparent crystallite size was attributed to the development of larger crystallites and more ordered crystalline structures in the annealed TPCFs. Molecular orientation was an important factor to determine mechanical property of TPCFs.

Introduction

Thermoplastic liquid crystal polymers (TLCPs) are attractive because of their potential application as ultra-high strength fibers, and melt blends of TLCP and conventional thermoplastics have been extensively investigated due to their ease of processing and high performance [1-3]. As high performance polymers usually involve high cost and are difficult to process, it is very important to reduce their process cost without any decrease in their mechanical properties. In this research, TPCFs based on melt blends of PEN, PET, and TLCP were prepared by melt blending and spinning to achieve high performance fibers..

Experimental

Thermoplastics used were PEN and PET were supplied by Hyo Sung Co., and TLCP consisted of 80 mol% PHB and 20 mol% PET was purchased from Unitika Co. TPCFs were carried out by melt blending in a Haake twin extruder, and were melt spun in the extruder with four-hole spinneret. Mechanical properties were measured using an Instron 4465 tensile testing machine, and WAXD analysis was performed using a Rikagu Denki X-ray diffractometer. Birefringence and density of TPCF was measured using a Nikon polarizing microscope equipped with a K tilting compensator and density gradient column filled with carbon tetrachloride and *n*-heptane. Morphology of TPCF was observed using a Hitachi SEM model S-4200.

Results and Discussion

The reinforcement effect of the polymer matrix by TLCP component and TLCP fibrilar structure with high aspect ratios increased mechanical properties of TPCF. The improvement of the mechanical properties for TPCF also suggested that annealing could improve the crystallinity of TPCF because the amorphous region was crystallized and that the crystalline structures of TPCF became more ordered and perfect by annealing. The increase in apparent crystallite size with spinning speed was associated with development of larger crystallites and more ordered crystalline structures in TPCF. The increase in density and birefringence of TPCF with spinning speed was attributed to the effective chain packing and packed fiber structure and to improvement of orientation of the chains along the fiber axis. The degree of crystallinity and density of TPCF begun to increase rapidly at the birefringence value of approximately 0.095, and this region was considered as a break point, indicating occurrence of the orientation-induced crystallization [4]. Molecular orientation has affected tensile strength and modulus of TPCF.

Conclusions

The reinforcement effect of polymer matrix by TLCP and TLCP fibrillar structure with higher aspect ratios increased the mechanical properties of TPCF. The increase in the apparent crystallite size suggested that larger crystallites and more ordered crystalline structures were developed in TPCF. Molecular orientation was an important factor in determining mechanical property of TPCF.

References

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