

The Project Place

Microstructure and Properties of Thermotropic Liquid-Crystalline Polymer Blends and Composites

Liquid-crystalline polymers (LCPs), comprised of rigid (or semi-rigid) rod-like molecules, are usually classified into two groups: lyotropic LCPs and thermotropic LCPs, based on the conditions for the formation of their liquid-crystalline state.

Lyotropic LCPs, such as poly(*p*-phenylene terephthalamide) (PPTA) are processed to high-strength, high-modulus fibers by the solution-spinning technique. Thermotropic LCPs (TLCPs) are processed and molded to structural parts of different shapes by means of conventional processing for thermoplastics, such as extrusion and injection molding.

The synthesis and modification of TLCPs for different final applications are hot topics for industrial and academic research. The copolymerization of different comonomers produces copolymers classified into different series, (e.g. Rodrun, Vectra, and Xydar) with different liquid crystalline characteristics, melting temperatures, and rheological behavior. These series find their different end-use applications by injection molding, extrusion, stretching, blowing, and spinning.

In recent years, the rapid development of information technology products has led to an annual consumption growth of 25% for commercialized TLCP blends and composites. To fabricate final products, different commercialized grades of TLCP blends and composites are available as glass-fiber or carbon-fiber-reinforced, glass-bead, glass-flake, or silica-filled grades. The microstructure of commercialized TLCP blends and composites is closely related to their processing conditions. The relation between the rheological properties and the resultant microstructure of these blends and composites should be well established. The aim of this project is to evaluate the microstructure-property relation of the commercialized TLCP blends and composites by rheological measurement, morphological observation, and evaluation of property.

Recently, another report has been published in *Pure and Applied Chemistry* **76**, 2027-2049 (2004): "Rheological Properties and Associated Structural

Characteristics of Some Aromatic Polycondensates, Including Liquid-Crystalline Polyesters and Cellulose Derivatives," by J.L. White, L. Dong, P. Han, and H.M. Laun. This paper reports four different types of liquid crystalline polyesters and one type of glass, fiber-filled LCP, with sections as polarized light microscopy, capillary rheometry (bagley plots and correction vs. wall-shear stress), extrudate swell, structural studies of extrudates, and oscillatory shear measurements (amplitude sweeps, time sweeps, frequency sweeps, and temperature sweeps).



Inversion wall revealed by Spontaneous band texture in a liquid crystalline polymer; rigid copolyester of hydroxybenzoate (HBA) and hydroxynaphthoate (HNA) (1:1); Cross-polarised light microscopy. (Source: Dr W Song, Department of Materials Science and Metallurgy, University of Cambridge; www.doitpoms.ac.uk)

This project will focus on TLCP blends and composites. The topics of study include:

1. rheological measurements of TLCP blends and composites
2. dynamic viscoelasticity, stress relaxation, and shear/elongational viscosities
3. morphological observation of molded samples
4. scanning electron microscopy, transmission electron microscopy, and atomic-force microscopy observation
5. blending with other polymers
6. rheological properties of blends and microstructure observation
7. crystallization of TLCP blends and composites
8. differential scanning calorimetry measurements, scanning electron microscopy, and polarized optical microscopy observation
9. mechanical testing of molded samples
10. static mechanical properties and dynamic mechanical analysis

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 www.iupac.org/projects/2004/2004-044-2-400.html