

## Abstract

Thermotropic liquid crystalline polymers (TLCP's) are a special class of engineering thermoplastics which form highly ordered structure in molten states. Their rigid rod-like molecular conformation and the stiffness of the backbone chains impart a high degree of orientation during melt processing and forms fibrous structures in the final product. LCP has shown that they can impart fiber reinforcement when melt blended with thermoplastics and elastomers. The LCP is also capable of reducing the melt viscosity when blended with thermoplastics and elastomers. In the present investigation liquid crystalline polymer was melt blended with four different elastomers and two related thermoplastics to study the potentials of these blends as in-situ composites. The four elastomers and two thermoplastics taken to blend with liquid crystalline polymer are ethylene acrylic elastomer (AEM), fluorocarbon elastomer (FKM) with two grades, Viton B50 and Viton E60C, silicone rubber (VMQ), acrylic elastomer (ACM), poly(butylene terephthalate) (PBT) and poly(ethylene terephthalate) (PET). The blends of elastomers and thermoplastics with liquid crystalline polymer were prepared by melt mixing technique at different blend ratios. The mechanical, crystallinity, dynamic mechanical, thermal, morphological and cure properties of these blends were investigated.

Rheometric study on the AEM/LCP and VMQ/LCP blends showed a drop in the melt viscosity of the elastomers with the addition of LCP. Whereas, in the case of FKM/LCP and FKM/ACM/LCP blends, the viscosities were increased with the incremental increase of LCP content in the blends. These results suggested that the viscosity of the elastomers/LCP blends depends on the fibrillation of LCP domains, and its distribution in the matrix phase.

The reinforcing characteristic of LCP mostly depended on the fibrillation of LCP domains in the matrix phase and adhesion between LCP and matrix phases. At lower level of LCP, cracks on the sample surfaces associated with the matrix flow. At higher level of LCP, failure occurred mainly due to pullout of fibrils from the matrix, because of insufficient adhesion between LCP and matrix phases.

XRD study revealed an increase in the crystallinity of the blends with the increasing LCP content. This suggests that the addition of LCP induces some crystallinity in the blend. This is attributed to be due to the dispersion of the LCP phase in the form of crystalline fibrils.

Dynamic mechanical analysis results, at 1Hz, showed the shift in the glass transition temperature ( $T_g$ ) of the elastomers with the addition of LCP and the improvement in storage modulus for all these blends is prominent above the  $T_g$ s of their respective elastomers. From the thermo-gravimetric analysis (TGA), we found that the thermal stability of the elastomers enhanced by blending with the LCP.

The master curves from simple horizontal shifts of the storage ( $E'$ ) and loss ( $E''$ ) moduli were satisfactorily fit by the empirical William-Landel-Ferry (WLF) equation. The WLF and Arrhenius equations were used to describe the shift factors obtained from multiple frequency experiments near the glass transition temperatures. The glassy moduli of the LCP filled and unfilled elastomers were found to be comparable, but the rubbery moduli of the LCP filled elastomers were much higher than the LCP unfilled system. However, the viscoelastic behaviour of these systems and their sensitivity to time temperature may be considered to be quite similar.

The influence of interactions on thermal and dynamic mechanical properties of the blends of ACM/PBT/LCP and ACM/PET/LCP were investigated over the complete composition range. The FTIR spectroscopy analysis showed

reduction in the intensity of the peak corresponding to epoxy groups of ACM with increasing heating time at about 300 °C; this implies that there is a chemical reaction between the epoxy and the end groups of PBT, PET and LCP. Glass transition temperature ( $T_g$ ) and melting temperature ( $T_m$ ) of these blends were affected depending on the LCP weight percent in the ACM/PBT and ACM/PET blends, respectively. This further suggests the strong interfacial interactions between the blend components. In presence of ACM, the nucleating effect of LCP was more pronounced for the PBT and PET phase.

**Key words :** Liquid crystalline polymer, ethylene acrylic elastomer, fluorocarbon elastomer, acrylic elastomer, silicone rubber, poly(butylene terephthalate), poly(ethylene terephthalate), polymer blends, crystallinity, thermal stability, compatibility, time-temperature superposition, morphology, activation energy, activation entropy