Dynamic Rheological Characterization of A Thermotropic Liquid Crystalline Poly (aryl ether ketone)

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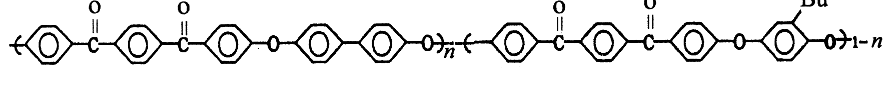
Abstract: The rheometrics ARES rheometer was applied to determining the rheological behavior of a thermotropic liquid crystalline poly (aryl ether ketone). The viscosity of the material decreases with increasing temperature, reaching a minimum in the nematic state, then slightly increases with further raising the temperature in the biphase.

Keywords: Poly (aryl ether ketone), liquid crystal, nematic, viscosity, rheology.

Poly(aryl ether ketone)s (PAEKs) have been widely used as advanced materials in applications because of their excellent thermal stabilities and good chemical resistance[1]. The high melt viscosity is one of the major drawbacks in processing them. The synthesis of thermotropic liquid crystalline PAEKs has shed light on the solving of this problem[2] because they have been proved to have melt viscosities significantly lower in nematic state than those of the isotropic PAEKs and can be melt processed in the liquid crystalline state to form high-strength fibers. In the present work, we report the viscosity behavior of this material upon heating. The minimum of viscosity was observed in the nematic state.

The liquid crystalline PAEK used in this paper was the random copolymer of 4,4'-biphenol, *t*-butylhydroquinone and 1,4-bis(4-fluorobenzoyl)benzene. It has a nominal melting point at 333°C and an isotropic transition around 397°C. The method of the synthesis was described in our previous paper[3]. The structural formula is as follows.



The dynamic rheological measurement was performed on an ARES(Advanced Rheological Expansion System, Rheometric Scientific) with parallel-plate geometry. Before applying a frequency sweep, the sample was tested at each temperature to determine the range of its linear viscoelastic response. All the experiments were carried out under nitrogen atmosphere to avoid sample oxidation.

Results and Discussion

Dynamic frequency sweep gave the plots of complex viscosity as a function of angular frequency at different temperatures, as shown in **Figure 1.** In **Figure 1** one can find that the viscosity always decreases with the increase in frequency at each temperature, showing the shear thinning behavior. Specifically the viscosity of the sample is higher at 400 °C than at 390°C. It means that the sample entered biphase. **Figure 2** showed the viscosity variation with the temperature at an angular frequency of 10 rad/s. The viscosity gradually decreased with increasing the temperature. When the temperature was increased to 390°C, the viscosity reached a minimum value, then it was increased slightly with increasing temperature. It will presumably decrease again at temperatures higher than 400 °C.

Figure 1 Plots of viscosity *versus* frequency at different temperatures

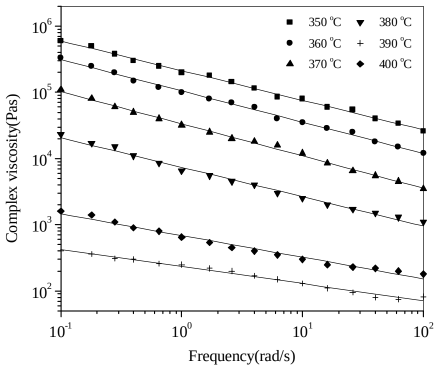
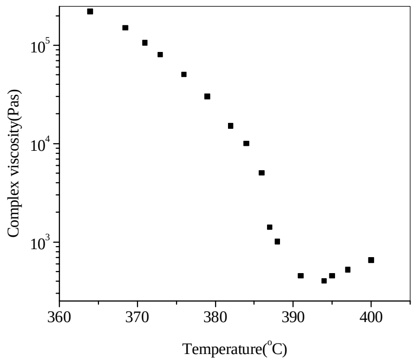


Figure 2 Temperature dependence of complex viscosity



The above viscosity behavior associated with the mesophase of PAEK is of importance to process of this material. Our work is believed to be the first rheological investigation of thermotropic liquid crystalline poly (aryl ether ketone).

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References

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