

## CHAPTER I

### INTRODUCTION



#### 1.1 General Introduction

Polymers are widely used in practice because of their unique rheological and physicomechanical properties [Yanovsky, Y. G. 1993]. They differ from other substances in the size of their molecules, which can be called macromolecules.

Polymer liquids have high viscosity when compared to other small molecular liquids due to their long chain nature. The presence of long chain entanglements accounts for the changes of viscosity with molecular weight ( $M$ ). The melt viscosity is proportional to  $M$  at low molecular weight and to  $M^3$  for higher molecular weight for various polymer. Processing of polymer melts becomes more difficult with increasing molecular weight (increasing melt viscosity).

The varieties of additives are available to improve specific properties of polymers. But they tend to have the negative effects on other properties. Reinforcing fibers and other fillers are popular as an additive for polymers. In general, fibers and solid fillers tend to increase the modulus of a composite when used in proper amount and proper directions. However, the negative properties of adding fiber to the mixed polymers are the increase in the melt viscosity.

Liquid crystal polymers are the polymers whose molecules can be aligned in some certain directions. The most common liquid crystal is the LCD display. The liquid crystal of LCD aligned their molecules subjected to the electricity. There are other liquid crystals that aligned their molecules subjected to heat (Thermotropic liquid crystal), or when dissolved in solvents (Lyotropic liquid crystal). The lyotropic liquid crystalline is usually used in fiber forming processes. The thermotropic liquid crystalline is usually used in melt mixed processes. The thermotropic liquid crystallines are the main concern in this research.

Novel properties have been found when blending conventional thermoplastics with liquid crystal polymers (LCP). LCP were known as a new class of engineering polymers. The main purpose of blending LCP into isotropic polymer is to get *a blend with a decrease in viscosity and an increase in mechanical properties*. Oriented LCP can lubricate the polymer melt and lower the melt viscosity. The reduction of the viscosity of blends allows a reduction in processing temperatures. For this reason, they have been the subject of active research interests in the past decade.

There have been a considerable number of papers in the literatures dealing with phase transitions, characterization of mesophases (the phase that molecules of liquid crystal have an alignment), flow behavior and mechanical properties of these materials. For example, Lin, Y. G. and co-worker reported that addition of 2 %by weight LCP reduced the viscosity of PET about 60%. A drop in the viscosity of PC of about 30% and 50% was observed by Nobile, M. R. for the 5 and 10% blend of LCP, respectively. In this research, the blends of low molar mass liquid crystals were study in

stead of liquid crystal polymer (LCP). The amount of liquid crystals that used in our research are only 0.25-1 percent by weight.

The addition of low molar mass liquid crystals to amorphous polymers were suggested as an alternative method to induce a modest improvement in the mechanical properties of the resulting polymer composites. Due to the mechanical anisotropy which results from molecular alignment, the liquid crystal molecules can orient themselves in the shear field characteristic of a processing operation [Patwardhan and Belfiore, 1988].

In United States patent [4,434,262], Buckley, A., Conciatori, A. B., and Calundann, G. W. [1984] studied an improved melt processable blend comprising of a polymer selected from the group consisting of a polyolefin and a polyester and a low molar mass liquid crystal compound which is capable of forming an anisotropic melt phase at the melt processing temperature of the blend.

Consequently, the present study deals with a system composed of a thermoplastic polycarbonates and low molar mass thermotropic liquid crystal. Two liquid crystals: CBC33, CBC53 from Merck co. Ltd., were chosen to blend with engineering thermoplastic: poly(bisphenol A carbonate) (PC) because the melting viscosity of PC is very high, and it is difficult to process this material. The reason for choosing these two liquid crystals because they have nematic region between the processing temperature of PC.

The shear viscosity determined by using a capillary rheometer were observed in this work. The tensile properties were also determined in order to see the effects on the mechanical properties.

## 1.2 The Objectives of the Present Study

1.2.1 To investigate the effects of blending low molar mass thermotropic liquid crystals on shear viscosity of poly(bisphenol A carbonate).

1.2.2 To study the effects of molecular weights of polycarbonates on the blend viscosity.

1.2.3 To examine the various composition for blending and mechanical properties of the blends with liquid crystals that have various anisotropic phases.

## 1.3 The Scope of the Present Study

The present report is concerned with four PC having different molecular weights and two liquid crystals (CBC33, CBC53). The shear viscosities of the polymer blends of PC with low molar mass thermotropic liquid crystal at the low concentration of low molar mass liquid crystals will be determined. The tensile properties and DSC thermograms of each blend will be investigated.