



CHAPTER I INTRODUCTION

Polymers are important industrial materials. Their mechanical, physical and electrical properties can be altered to satisfy a wide range of applications. Diverse applications require different types of polymer. New polymers have to be synthesized in order to fulfill industrial and technology requirements. But synthesizing new polymers involves exorbitant costs and time. Therefore, synthesizing new polymers is not always the suitable answer to solve the lack of desired materials. An alternative route to solve this problem is to modify specific properties of existing polymers through blending. Blending polymers is an economical method of manufacturing new products with defined properties.

Many polymers blends are immiscible. When two immiscible polymers are mixed together; one polymer forms a major phase (the matrix phase) and the other one form a minor phase (the disperse phase). The minor phase tends to form spherical drops embedded in the major phase under equilibrium condition.

Properties of immiscible blends do not depend only on the properties of their components alone but also depend on the minor-phase morphology. The size, shape of drops and size distribution which result from mixing process can influence the final properties of the blend. The final morphology is controlled by the rheological and physicochemical properties of constitutional polymers, as well as the processing conditions. A better understanding of these conditions is required to predict the desired final product morphology. If the properties of polymer blend can be controlled, the material will meet specific applications.

The pioneering work was by Taylor in 1932 who studied the steady state deformation and breakup of a Newtonian drop. For small deformation, he found that the drop deformation is governed by two dimensionless parameters; the first is the capillary number: the ratio of the matrix viscosity to the interfacial tension, which is defined as

$$Ca = \frac{\eta_m \gamma D_0}{2\Gamma} \quad (1.1)$$

where γ is the shear rate, D_0 is the initial radius of the droplet, and Γ is the interfacial tension. Another parameter is viscosity ratio;

$$\eta_r = \frac{\eta_d}{\eta_m} \quad (1.2)$$

where d and m stand for disperse phase and matrix phase, respectively.

Moreover, for small deformation, the shape of droplet is gradually deformed to a steady state ellipsoid shape. The major axis orients at the constant angle, 45° with the flow direction. He also defined the deformation parameter (Def) as a function of capillary number and the viscosity ratio:

$$Def \equiv \frac{a-b}{a+b} = Ca \frac{19\eta_r + 16}{16\eta_r + 16} \quad (1.3)$$

where a is the major axis and b is the minor axis of the deformed drop.

Taylor also predicted that the droplet breakup should occur when the viscous force that deforms the drop overwhelms the interfacial tension that resists the deformation. This occurs when the deformation parameter (Def) is approximately 0.5. He revealed the two major exceptions: when the viscosity ratio is low (less than 0.05), the droplets deform greatly before they break, and when the viscosity ratio is larger than 4, the deformation remains modest despite undergoing high capillary number, and no breakup is observed (Grace 1982). These results show that for Newtonian fluids, droplet deformation and breakup are strongly influenced by viscosity ratio. Grace (1982) found that, for steady state shearing, for an isolated Newtonian droplet in Newtonian matrix the minimum critical capillary number occurs when the viscosity ratio is around unity.

The time-dependent flows have received very little attention. Normally the droplets in the equilibrium state are of a spherical shape which is independent of any

deformation history. The application of steady shear from the rest is one obvious case that has already received some attention. Another time-dependent deformation is the application of oscillatory shear, where both amplitude and frequency of deformation can be controlled.

In our work reported here, we take a further step towards understanding the behavior of immiscible blends under oscillatory shear by using Newtonian fluids for both the droplet phase and the matrix phase. Using a flow cell mounted on an optical microscope, we observed the deformations of isolated droplets in oscillatory shear flow between parallel disks. The effect of viscosity ratios, time scale ratio, and the elasticity of disperse phase were investigated.