CHAPTER 1
INTRODUCTION

Nowadays, because of concerns for global environmental problems and biomedical applications, biodegradable polymers are becoming increasingly important worldwide. The microbial polyester family is one of the biodegradable sources which have attracted industrial attention as an environmentally biodegradable and biocompatible thermoplastic. From this group, poly-3-hydroxybutyrate, is a linear polyester that produced by many strains of bacteria in fermentation. Its chemical structure is: $-[O\text{-}CH(R)\text{-}CH_2\text{-}(C{=}O)]-$ with $R=CH_3$ for PHB and $R=C_2H_5$ for PHV. PHB was discovered in 1925 in the Lemoigne laboratory. It is the first and only polymer from PHA group which is produced in large quantities. PHB is biodegradable, biocompatible and its good barrier properties make it an important choice for solving environmental pollution problems of packaging industry. Despite its good properties, high production cost and low thermal stability limit its actual commercial utilization. In addition, high degree of crystallinity, low nucleation density and the glass temperature near to room temperature lead to poor mechanical properties and make it brittle with high yield stress and low impact strength.

Much work has been done to understand the reason for the brittleness of PHB in order to improve its physical properties. De Koning and Lemstra (1993) declared that the embrittlement of PHB occurred during storage after the initial crystallization from the melt because of the secondary crystallization which happens in the reorganization of lamellar crystals formed during the initial crystallization.

Due to the fact that PHB has a very low resistance to thermal degradation and decomposes at temperature near its melting point, improving thermal stability of PHB has a very critical position for actual uses of this material. Otherwise, there is always limitation for processing, application and thermal recycling. On the other hand, toughening PHB is necessary to give it a try in the world market.

In an attempt to improve PHB properties, copolymerization with another material such as 3-hydroxyvalerate was developed. However, the improvement in properties is limited and the cost remains high. In addition, there is a limitation in carbon sources, the kind of bacteria and mechanism. Blending with a second polymer is one effective method to improve thermal stability, processability and mechanical properties of polymers. Therefore, finding a suitable polymer to blend with PHB is a key that could lead to desired properties of the resulting blends.

Poly (lactic acid), PLA, is a typical biodegradable synthetic polyester; commercially obtained by ring opening polymerization of lactones or by polycondensation of hydroxycarbonic acids. PLA is degraded by hydrolysis in the presence of water to lactic acid and this makes it suitable for medical and surgical use. Considering these points, blending with PHB can make a desired blend which will offer various usages in biomedical applications.

In order to have suitable temperature and environmental stability, high performance thermoplastics usually have a certain degree of crystallinity and it is important to study miscibility and crystallinity of polymer blends which have at least one component crystallizable. Consequently, the final properties of the blends depend on the miscibility of components, crystallinity and final morphology during processing. It shows the importance of studying the effect of crystallization condition on crystallization kinetics, structure, morphology and physical and mechanical properties.

There are a lot of published articles which show the amount of work done on blends of PHB with other polymers. Miscible blends have been proposed by mixing PHB with poly (vinyl acetate) (PVA), poly (epichlorohydrine), poly (vinyl phenol), poly (vinylidine fluoride), poly (ethylene oxide), etc. On the other hand, there are immiscible blends of PHB and poly (caprolactone), poly (cyclohexyl methacrylate), poly (hydroxyoctanoate), high molecular weight poly (L-lactide), poly (methylene oxide), etc; while there are just few papers available on blending PHB with low molecular weight PLA.

In this research, attempts had been done to prepare and characterize PHB and its blends with PLA by focusing on miscibility, macroscopic and microscopic crystallization behavior, melting behavior, and spherulitic morphology of the resulting blends in the range that they were found to be miscible.