CHAPTER I

INTRODUCTION

In recent years, petroleum based plastics are utilized in almost every manufacturing industry because they can be manipulated to have a wide range of mechanical properties and shapes. Plastics are also cheap, durable and have a high chemical resistance. Unfortunately, these useful characteristics can make petroleum based plastics a serious pollution problem. Petroleum based plastics resist to microbial degradation because of their excessive molecular weight [Jogdand, 1999]. Moreover, there is no bacteria that has been exposed to plastics through the course of the plastics evolution [Paustian, 1998]. The amount of plastic waste exceeds 100 million tons a year all over the world [Jogdand, 1999]. There are many ways to deal with plastic waste including incinerating, landfill and recycling. Each method has its own disadvantages. Plastic incinerating is expensive and dangerous because harmful chemicals like hydrochloric acid (HCl) and hydrogen cyanide (HCN) can be released during incineration [Paustian, 1998]. There are some weak points in recycling. Firstly, it is difficult to sort plastics into certain types. Secondly, the properties of recycled plastics are changed so the application of recycled plastics is limited [Paustian, 1998]. Landfill is the safest and cheapest way to deal with plastic waste but the capacity of landfill of the world is reaching the maximum while the amount of the plastic waste keeps rising up [Paustian, 1998].

From the legislative pressure and environmental concern, biodegradable polymers become the attractive solution of the plastic waste problem. Biodegradable polymers can be classified into three [Paustian, 1998] as follows:

1. Photodegradable polymer,
2. Starch-linked or semi-biodegradable polymer,
3. Bacterial or biodegradable polymer.

Photodegradable polymer has UV sensitive functional groups incorporated into the backbone of the structure of polymer so it can be discriminated into small fragments when exposed to UV radiation for extensive time interval (from several weeks to months) [Paustian, 1998]. If photodegradable polymer was buried into the ground as landfill, it can not be degraded because it is not exposed to the sunlight. This is the weak point of photodegradable polymers.

Polymer blend of starch and polyethylene is the sample of semi-biodegradable polymer. Once the semi-biodegradable polymer is discarded into the soil, theoretically it is postulated that starch fraction in polymer is degraded by bacteria and polymer is turned into small fractions of polyethylene that can be further degraded by other types of bacteria [Jogdand, 1999]. However, degradation of semi-degradable polymer does not follow the theory. Bacteria can degrade only starch fraction and leave polyethylene fraction undegraded in the soil. The undegraded fraction still pollutes the environment.

Biodegradable polymer available today include starch, cellulose acetate, microbial polyester, polyvinyl alcohol, polycaprolactone, polylactic acid, polyethylene, polyurethanes,polyhydroxyalkanoates and blends of some of these polymers [Rapra Technology Limited, 1999].

Polyhydroxyalkanoates or PHAs can be produced by fermenting a sugar feedstock with a variety of different microorganisms and can be completely degraded into carbon dioxide and water by many species of microorganisms found naturally in soil, sewage and environment [Doi, 1990]. One of the most interesting PHAs is poly(β-hydroxybutyrate) or PHB.

PHB is a thermoplastic polymer that can be manufactured for a variety of applications [Lee, 1996] as follows:

1. Disposable items: razor grip, shampoo bottle, etc,
2. Medical applications: prosthetic devices, surgical swaps, wound dressing and drug control release materials.

The main obstacle in utilizing of PHB is its poor mechanical property, i.e., it is rather hard and brittle [Griffin, 1994]. Therefore, the object of this work is to characterize and study the mechanical properties of PHB in order to modify its mechanical properties without losing its biodegradation properties

1.1 Project objective

1.1.1 To study the characteristics, physical and mechanical properties of PHB

1.1.2 To study the effects of modifying agents including propylene glycol (PG), polypropylene glycol (PPG) and epoxidized soybean oil (ESO) on the mechanical properties and morphology of PHB

1.2 Scope of the project

1.2.1 Study the characteristics and properties of PHB

1.2.1.1 Fundamental characteristics of PHB, i.e., functional group and molecular weight.

1.2.1.2 Thermal properties of PHB, i.e., melting temperature (T_m), glass transition temperature (T_g), heat of fusion (ΔH_f) and degree of crystallinity.

1.2.2 Study the effect of the modifying agents on mechanical properties and morphology of PHB

1.2.2.1 Study the effect of PG, PPG and ESO on the mechanical properties of the PHB/modifying agent blends.

1.2.1.2 Study the effect of the polypropylene glycol on the morphologies of the PHB/PPG blends.