

CHAPTER I

INTRODUCTION

The use of stationary produces from plastic in our daily cause the plastic waste problems. The information from Pollution Control Department was reported that the amount of plastic waste is 2.7×10^6 tons/year (Pollution Control Department, 2008). The growing of plastic waste is the most serious problem for environmental and life quality that can recognize and solve urgently. Therefore, biodegradable plastics can be replaced the commodity plastics for reducing the large amount of plastic waste problem. The biodegradable polymers can be classified by two categories: (1) renewable resources, such as, polylactide (PLA), polyhydroxyalkanoate (PHA), thermoplastics starch (TPS), cellulose and protein. (2) petrochemical resources, such as, aliphatic polyester and copolyester, aromatic polyester and copolyester, poly(caprolactone) (PCL), poly(esteramide)s (PEA) and poly(vinyl alcohol) (PVA).

Polylactide (PLA) is hydrophobic aliphatic polyester that the mechanical and thermal properties are comparable with the traditional thermoplastics. PLA is prepared by two ways, the polycondensation polymerization of lactic acid and the ring-opening polymerization of lactide. The ring-opening polymerization of lactide is the way to get high molecular weight of PLA. Not only the polymerization method, but the temperature of mixing and the catalyst content also affect to molecular weight. Hyon *et al.* synthesized polylactide with different molecular weight. They found that the increase of temperature and catalyst content resulted in the decrease in molecular weight. Moreover, PLA is being commercially produced for commodity application, for example, fibers, the internal fixation of bone fractures, and injection molding objects. Even through, PLA has many advantage properties but it has some disadvantages such as, rigidity, slow rate of crystallization and slow rate of biodegradation.

There are several methods to overcome the limitation of PLA such as processing, plasticization, blending, and copolymerization. The great method to improve limitation of PLA is copolymerization of lactide or lactic acid monomer

with the other monomers because it is not occurred phase separation. There are two ways to prepare copolymer of PLA. The first way is polycondensation of lactic acid copolymerized with other monomers that produced low molecular weight copolymer. The second way is ring-opening copolymerization of lactide monomer with cyclic monomer that produced high molecular weight copolymer. Noocaid *et al.* successfully synthesized the EVOH-g-PLA copolymer in Barbender mixer. The composition of EVOH/LA at 50/50 wt% gave the highest molecular weight ($M_w = 36.6 \times 10^4$ g/mol). Furthermore, the optimum of mechanical properties was found in this composition.

Epoxidized Natural Rubber (ENR) is the natural rubber that some part of double bonds is replaced by epoxide groups. ENR has many good mechanical and thermal properties offering high strength, due to their ability to undergo strain crystallization, along with increasing glass transition temperature and high degree of damping. There are many researchers studied ENR blend with other polymers to improve properties of each polymer. For example, G.H. Yew *et al.* blended ENR with poly(lactic acid)/rice starch to improve brittleness of poly(lactic acid), the result showed that poly (lactic acid) had more rubbery behavior.

The purpose of this research is to improve the toughness of PLA by copolymerization between lactide monomer and epoxidized natural rubber using stannous (II) octoate ($\text{Sn}(\text{Oct})_2$) as an catalyst. The epoxy group in ENR can initiate the ring-opening polymerization of lactide monomer. This leads to high molecular weight and toughness improvement of PLA. There by, this work studies the effect of the blend ratio, the catalyst content, and the temperature of mixing on the morphology, mechanical properties, thermal properties and biodegradability of ENR-g-PLA copolymer.