Chapter 5

Conclusion and Recommendations

PLA-based aliphatic-aromatic copolyesters with different chemical structure and properties have been synthesized and characterized in order to incorporate the degradability of PLA and good mechanical property of aromatic species. Synthesis of the copolymer was conducted by polycondensation of lactic acid with dimethyl terephthalate (DMT) and various diols using stannous(II)octoate as a catalyst. Four types of diols with different methylene length were employed, i.e., ethylene glycol (EG), propylene glycol (PG), 1, 3-propanediol (PD) and 1, 4-butanediol (BD). Effects of diol and comonomer molar ratio on the polycondensation and the molecular weight of resulting copolymers were investigated. Diacid/ diol ratios of L-lactic acid (LLA)/ dimethyl terephthalate (DMT)/ diol of 1/1/2, 1/2/4, and 2/1/2 were employed, respectively.

Effects of Diols: Effects of diols on molecular weight and thermal properties of the copolymers indicated that BD diol provides copolymer with highest molecular weight, compared to that of shorter chain diols. This is probably because the longer methylene sequence in BD units provides an optimum flexibility and reactivity for its hydroxyl groups to react with acid functional groups. This leads to a higher extent of reaction and hence a production of higher MW copolymers. Results on thermal properties indicate that copolymers derived from EG, PD and BD diols are semi-crystalline, as reflected by the existence of melting temperature, while that of PG is completely amorphous copolymer as a result from the disruption of crystal formation from side chain methyl groups in the repeat units. This side chain also leads to an increase in Tg value, compared to that of its EG counterpart. In addition, copolymer derived from BD shows the lowest Tg at 26°C due to the flexibility of the chain provided from the longer methylene sequence in its repeating units.

Effects of Monomer Molar Ratios: The effects of LA/DMT/diol monomers molar ratios on molecular weight, Tm, and Tg of the resulting copolymers derived from EG, PD and BD diol. The results indicate that a ratio of 1/2/4 provides the copolymer with the highest MW, Tm, and Tg. Copolymers derived from the ratios of 1/1/2 and 1/2/4 are semi-crystalline polymers, reflected by the existence of Tm near 200°C. On the other hand, the derived from 2/1/2 ratio EG and PG leads to a formation of amorphous copolymer. This is perhaps due to a reduction in aromatic content in the copolymer chain, which is responsible for a formation of crystalline domains and the 2/1/2 copolymer derived from PD and BD leads to lower Tm that existing near 135°C. In addition, the increase in the aromatic content also leads to an increase in the glass transition temperature of the copolymers. The results indicate that copolymer with the highest molecular weight is obtained when BD is employed. Monomer molar ratio also has significant effect on MW and thermal properties of the copolymers, where the higher the aromatic content leads to a formation of copolymers with higher MW and higher Tg and Tm values.

The results of degradability suggest that a ratio of 2/1/2 provided the copolymer with the highest degradability, compared to that of the other copolymer. This is probably because the higher aliphatic LA component in the chain provides higher degradable property. Copolymers derived from the ratios of 1/1/2 and 1/2/4 show lower degradability. This is perhaps due to the higher aromatic content in the copolymer chain,

which is responsible for non-degradable polymer part. Also, the higher aromatic content results in the lower value of the degradability.