Clay를 첨가한 폴리락트산 중합체의 제조 및 특성

최용혁, 손태원, 정민기, 김대선, 이광순
영남대학교 섬유패션학부

Preperation and Properties of Poly(L-lactic acid)(PLLA) Polymers Containing Small Amount of Clay

Y. H. Choi, T. W. Son, M. G. Jeong, D. S. Kim, and K. S. Lee
School of Textiles, Yeungnam University, Gyeongsan 712-749, Korea

1. Introduction

Poly(lactic acid) (PLA) is a highly versatile, biodegradable, aliphatic polyester derived from 100% renewable resources, such as corn and sugar beets. Because of the degradation mechanism, PLA is ideally suited for many applications in the environment where recovery of the product is not practical, such as agricultural mulch films and bags. Composting of post consumer PLA items is also a viable solution for many PLA products. However, the large growth seen for PLA in many applications dose not depend upon the biodegradability of the material. PLA resins can be tailor-made for different fabrication processes, including injection molding, sheet extrusion, blow molding, thermoforming, film forming, or fiber spinning. Lactic acid exists in two different optically active stereoisomeric forms; therefore, three different lactides can be formed: L(-)-lactide (s,s), D(+)-lactide (R,R) and the optically inactice meso-lactide (R,S).

PLA can be prepared by either condensation polymerization of the free acid or by catalytic, ring opening polymerization of lactide, which is the dilactone of lactic acid. PLA has certain good physical properties such as high strength, thermoplasticity and fabricability. However, PLA is still more expensive than conventional plastic, and the degradation rate is not completely satisfactory in some instances (e.g., municipal composting).

2. Experimentals

2.1. Materials

L-Lactic acid (LLA) was purchased as a 85 wt% aqueous solution from Aldrich chemical co.(U.S.A), and used without further purification. Tin chloride 98%($Sncl_2$) and montmorillonite k-10 (MMT) were purchased from Aldrich chemical and P-xylenes was purchased from Juncei chemical, (Japan).

2.2. Synthesis of Poly(L-lactic acid)

A 250 mL three-necked flask was equipped with a thermocouple, a mechanical stirrer, and an outlet to vacuum system connected to condenser and the cold trap. PLA was polymerized by LLA, p-xylene solution and Tin chloride were used as solvent and catalyst, respectively.

2.3. Measurements

Thermal properties of the synthesized polymers were measured using a differential scanning calorimeter (DSC, TA Instrument 2010, Dupont, U.S.A). The samples were heated at 10℃/min under nitrogen from 30℃ to 200℃, held at this temperature for 5min, and subsequently cooled down to 0℃ at a cooling rate of 20℃/min, and heated at 10℃/min from 0℃ to 250℃. A Thermogravimetric Analyzer (TGA, TA Instrument 2050, Dupont, U.S.A) was used to investigate

the thermal stability of synthesized polymer. TGA experiment was performed at a scanning rate of 20℃/min from 30℃ to 600℃ under nitrogen atmosphere.

Fourier-transform infrared spectroscopy(FT-IR) was used to analyze the chemical structure of synthesized polymers. The FT-IR spectrum from 4000㎝$^{-1}$ to 600㎝$^{-1}$ of prepared samples in solid state was obtained by the KBr method.

Proten (^{1}H) nuclear magnetic resonance (NMR) spectra were recorded on a Bruker DPX-300 SY spectrometer at 300MHz for all the polymers. ^{1}H NMR chemical shifts in parts per million (ppm) are reported down-field from 0.00 ppm using tetramethylsilane (TMS) as an internal reference. For all the polymers, 30~40㎎ was dissolved in chloroform-*d* solvent.

3. Results and Discussion

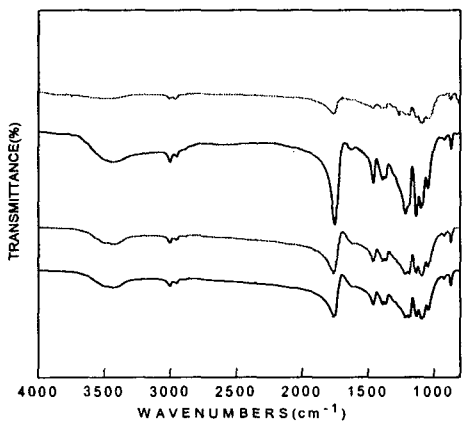

Fig. 1. Infrared spectra of PLA/Clay composites having different clay contents.

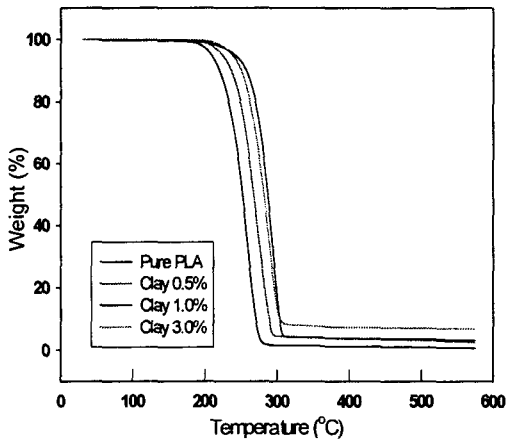

Fig. 2. TGA thermograms of PLA/Clay composites shaving different clay contents.

Generally, PLA/Clay composites were more thermal-stable than pure PLA. However, PLA/Clay composites having clay content of above 1% weren't showed significant increase of thermal stability.

Acknowledgement : This work has been supported by both Regional Research Center (RRC) at Yeungnam University and Korea Industrial Technology Foundation (KOTEF). The authors gratefully acknowledge the continually financial support and encouragement provided by both RRC and KOTEF during the course of this study.

4. References

1. By Ray E. Drumright, Patrick R. Gruber, and David E. Henton Adv., Mater., **23** (2000)
2. S. H. Kim, and Y. H. Kim. Korea Polymer J., **5**. p1. (1997)
3. W. J. Kim, S. Y. Lee, J. H. Kim, S. H. Kim, and Y. H. Kim. J. Korea Ind. Eng. Chem. **10**, p. 7, (1999)
4. S. G. Lyu, D. Y. Park, K. S. Bae, and G. S. Sur. Polymer Korea J., **25**, p.3 (2001)
5. H. K. Choi, Y. H. Park, S. G. Lyu, B. s. Kim, and G. S. Sur. Polymer Korea J., 23, p.5, (1999)
6. Mihir Sheth, Vipul Dave, Richard A cross. ANTEC 1995