

論文 / 著書情報
Article / Book Information

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著者(和文)	KULTRAVUTKatanyu
Author(English)	Katanyu Kultravut
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Type(English)	Summary

論文要旨

THESIS SUMMARY

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学生氏名： Student's Name	Kultravut Katanyu		指導教員 (主)： Academic Supervisor(main)	扇澤 敏明 教授	
			指導教員 (副)： Academic Supervisor(sub)	-	

要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

In this study, developments of the drawbacks of biodegradable poly(lactic acid) (PLA) such as brittleness and low thermal stabilities were investigated by blending with poly(trimethylene terephthalate) (PTT) because PTT shows good mechanical properties and thermal stabilities.

In chapter 2, poly(ethylene-*co*-glycidyl methacrylate) (PEGMA) was added in the PLA/PTT blends as a reactive compatibilizer in this blend because the epoxy groups in PEGMA can react with both carboxyl and hydroxyl groups in both polyesters. Two-step blending was applied as a blending procedure in this study because it is desirable to form the graft-copolymer of PLA-*g*-PEGMA-*g*-PTT and the copolymer should exist at the interface between PLA and PTT phases. Therefore, PTT was pre-mixed with PEGMA for 2.5 minutes, then PLA was added and continued the blending process (two-step blending) more 2.5 minutes. The amorphous PLA/PTT/PEGMA blends by two-step blending were investigated in this chapter by quenching samples. Tensile properties, especially strain at break of the blends in all compositions prepared by two-step blending were drastically improved. From the morphology observation, the size of PTT dispersed phase was decreased compared with the blend prepared by the one-step blending. The PEGMA particle was located at the interface between PLA matrix and PTT dispersed phases. Moreover, the PLA-*g*-PEGMA-*g*-PTT copolymer formation was confirmed by a Fourier-transform infrared (FTIR) spectroscopy. These results indicate that PEGMA played a role as an effective compatibilizer by forming a PLA-*g*-PEGMA-*g*-PTT graft-copolymer at the interface between two phases. Moreover, the low thermal and hydrolytic stabilities of PLA were controllable in the PLA/PTT/PEGMA blends by two-step blending procedure. The thermal degradation temperature from TGA and residual mass from hydrolytic degradation test of PLA/PTT/PEGMA blend by two-step blending were noticeably higher than neat PLA and PLA/PTT/PEGMA blend by one-step blending.

In chapter 3, crystallized PLA/PTT/PEGMA blends were investigated to improve the thermal stability. All blends were annealed at the crystallization temperature of PLA, 110 °C. Although the crystallized polymer generally behaves more brittle manner than amorphous one, the PLA/PTT/PEGMA blends by the two-step blending behaved as ductile manner. By observations of the polarized optical microscope and laser light scattering, crystal formation without spherulitic morphology was observed in the blends by two-step blending. This must be the reason why the strain at break of the crystallized blends prepared by two-step blending were still higher than neat PLA. It indicates that the two-step blending was an effective method for making a high thermal stability PLA blends.

In chapter 4, both PLA and PTT in the PLA/PTT/PEGMA blend were crystallized using an annealing treatment in the temperature range of 90-120 °C, and a highly crystallized blends with the ductile manner were

obtained. The tensile properties of the annealed PLA/PTT/PEGMA blends by two-step blending were clearly improved compared with the annealed neat PLA and PLA/PTT blend. Even though the PLA/PTT/PEGMA blend was highly crystallized from the annealing, craze formation was observed. This is one of the dominant toughening mechanisms. The high crystallinity of PLA in the PLA/PTT/PEGMA blend could be prepared at a lower annealing temperature than the neat PLA due to the reduced cold crystallization temperature. Moreover, the isothermal crystallization kinetics during annealing were studied. The Avrami analysis suggested that the activation energy of crystallization in the PLA/PTT/PEGMA blend was lower than that in the neat PLA. Crystals without spherulitic structures in the PLA/PTT/PEGMA blend contributed to the tensile improvement due to the reduction of the stress concentration. Moreover, the hydrolytic stability of the crystallized PLA could be enhanced after blending with PTT and PEGMA.

In chapter 5, conductive composite based on PLA/PTT blend was investigated. Normally, adding the conductive filler in the polymer matrix is the one method to prepare the conductive composite. However, high amount of the filler are required to make a conductive path in the composite which is the reason of the mechanical properties reduction and high cost. To reduce the amount of the filler, the conductive filler was localized at the interface between each polymer of the co-continuous polymer blend. Graphene was modified by surface initiated of poly(glycidyl methacrylate) (PGMA) groups to make a PGMA grafted reduced graphene oxide (rGO-PGMA). The surface modification was confirmed by FTIR spectroscopy. The conductive PLA/PTT composite was prepared by blending with rGO-PGMA by two-step blending procedure. The effects of conductive filler were examined. As a result, it was found that using rGO-PGMA as a conductive filler was a successful method to enhance DC electrical volume resistivities and thermal diffusivities of the composite because rGO-PGMA located at the interface and formed a percolation threshold with low content. The DC electrical volume resistivities of PLA/PTT/rGO-PGMA composite were dramatically enhanced than neat polymer and PLA/PTT/Graphene composite. Moreover, the percolation threshold of rGO-PGMA in PLA/PTT/rGO-PGMA composites were investigated. It was shown that low content of rGO-PGMA formed a percolation threshold in the filler around 0.4 phr. Therefore, the PLA/PTT/rGO-PGMA composite produced by two-step blending show high potential for conductive application.

In chapter 6, summarizes the findings obtained from this study. To improve mechanical properties of PLA/PTT/PEGMA blends, the order of mixing was the key of development to improve the interfacial adhesion between PLA and PTT by PEGMA. Morphologies of blends could be controlled by blending method. Crazing mechanism in the blends by two-step blending could significantly improve the tensile properties. Making a graft-copolymer of PTT and PEGMA first followed by PLA adjusted a location of graft-copolymer to interfaces between PLA and PTT phase. Moreover, we succeeded fabrication of high crystallinity and tough PLA/PTT/PEGMA blend by controlling the annealing temperature. For the PLA/PTT/rGO-PGMA composite, the percolation threshold of rGO-PGMA in PLA/PTT/rGO-PGMA composites were investigated. Therefore, the PLA/PTT/rGO-PGMA composite produced by two-step blending show high potential for conductive composite.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note：Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1 copy of 800 Words (English).

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