論文 / 著書情報
Article / Book Information

題目(和文)	二軸配向高分子フィルムのレーザー穿孔における加工－構造－特性の関係
Title(English)	Processing-Structure-Property Relationship in Laser Perforation of Biaxially Oriented Polymer Films
著者(和文)	チャリニー ウィノタパン
Author(English)	Charinee Winotapun
出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第10676号, 授与年月日:2017年9月20日, 学位の種別:課程博士, 審査員:鞠谷 雄士,扇澤 敏明,森川 淳子,淺井 茂雄,塩谷 正俊
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第10676号, Conferred date:2017/9/20, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Organic and Polymeric Materials	専攻	申請学位(専攻分野)： Academic Degree Requested	博士 Doctor of	(Philosophy)
学生氏名： Student's Name	Charinee Winotapun		指導教員（主）： Academic Supervisor(main)	Prof.Takeshi Kikutani	
			指導教員（副）： Academic Supervisor(sub)		

要旨（英文 800 語程度）

Thesis Summary （approx.800 English Words）

This thesis entitled "Processing-Structure-Property Relationship in Laser Perforation of Biaxially Oriented Polymer Films" is consisting of seven chapters.

In chapter 1, the modified atmosphere packaging was introduced. The commercial plastic films normally have low gas permeability. These films cannot prolong the shelf-life of fruits and vegetables with high respiration rate. The aim and importance of this thesis was specified to investigate the effect of the higher-order structure of the films on the formation behavior of microholes through the detailed analyses of the laser perforation process as well as the investigations on the effects of processing parameters such as film thickness and laser fluence on the shape and size of the perforated microholes.

In chapter 2, the fundamental laser perforation behavior of the PP films prepared by simultaneous equi-biaxial stretching was investigated. In laser perforation, the opening and widening of a microhole and continuous growth of outer rim, and the starting of the volume loss were confirmed. The opening of a microhole proceeds while the laser is still irradiated, and the rate of the expansion of microhole diameter is fast enough in comparison with the duration of laser irradiation.

In chapter 3, the laser perforation behavior of the PP films prepared by simultaneous and sequential biaxial stretching of various MD and TD stretch ratios was evaluated. The effects of the slight molecular orientation toward MD during the casting of precursor film, and the preferred molecular orientation toward TD in the case of MD – TD sequential biaxial stretching were clearly found. Regarding the laser perforation behavior, the size of the perforated microhole was larger in the direction of higher molecular orientation, while lager hole size could be attained for the thinner film if the degree of molecular orientation was similar, and for the higher molecular orientation if the film thickness was similar. The formation of microhole was considered to be controlled by the surface tension and shrinkage of the film.

In chapter 4, the laser perforation behavior of the PLA films prepared by simultaneous biaxial stretching was investigated. The birefringence of the PLA film was analyzed, and the results similar to those obtained in Chapter 3, i.e. the larger hole size for higher draw ratio and thinner thickness, the larger hole size in the direction of higher molecular orientation, volume loss at high laser fluences, were obtained. Comparing the laser perforation behavior of the as-drawn films and annealed films, it was found that the opening of a microhole started at higher laser fluence, and at the same fluence the size of microhole was smaller in the annealed film. Through the comparison of the laser perforation behaviors of PP and PLA, the laser perforation of PLA films can be accomplished applying only 1/5 to 1/10 of the energy in comparison with the PP films because of its higher laser absorption coefficient.

In chapter 5, theoretical estimations of the temperature distribution along the film thickness and along the radial distance from the center of the laser irradiation were performed. Comparison of the calculated results with the experimental observations revealed that 1) for the PP film, the film surface deformed when the surface temperature reached its melting temperature, while the opening of a microhole started before the temperature reached the decomposition temperature, and 2) for the PLA film, the film surface started to change when the surface temperature reached the glass transition temperature, while the opening of the microhole proceeded along with the starting of volume loss at a temperature higher than the decomposition temperature. The difference between PP and PLA in terms of the laser perforation behavior was mainly originated from the difference of the absorption coefficient.

In chapter 6, the gas permeability of perforated PLA films was evaluated. Effects of the film thickness, and the number and shape of microholes on the gas permeability of micro-perforated film was investigated. The gas transmission rate of the microhole obtained as the difference between the gas transmission rates of perforated and no-perforated films increased with the decrease of film thickness and the increase of the area of microhole. There was a systematic increase of the β value, the gas transmission rate for the CO_2 divided by that for the O_2, with the increase of the film thickness for the circular microhole of similar size, and also with the increase of the aspect ratio of the microhole. These results suggested that the gas transmission rate can be slightly affected by the affinity of gas with the wall of microhole.

In Chapter 7, results obtained through this research were summarized.

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 (Eng l ish) or 1copy of 800 Words (English).
注意：論文要旨は、東工大リサーチリポジトリ（T2R2）にてインターネット公表されますので、公表可能な範囲の内容で作成してください。
Attention: Thesis Summary will be published on Tokyo Tech Research Repository Website (T2R2).