生醫用熱降解型高分子光彈解析之相關研究

Photoelastic Analysis of Thermo-degradable Polymer for Biomedical use

中文摘要

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論文名稱：生醫用熱降解型高分子光彈解析之相關研究
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生物可吸收性高分子材料在植入人體後，隨著組織的修復，其會慢慢的降解成小分子被人體吸收進而隨著身體代謝排出體外，具有如良好的生物相容性、合適的堅硬度、生物可吸收可代謝性，且無需第二次手術移除等優點。因此近年來可吸收高分子材料的開發應用，使骨內固定裝置發生質上的進步和轉變，而聚乳酸（ＰＬＡ）又是其中最受矚目的材料之一。然而，目前的研究多針對於如何對生物可吸收性聚乳酸高分子施以不同加工條件。對於所合成之高分子，能否有一樣便利易行、非破壞性且能精確反應出所合成之高分子性質的檢測工具，以作爲高分子合成時品質的即時監控。這方面的研究至今仍未獲得一清楚的了解。光彈檢測可用來偵測物品內應力狀態，且爲非破壞性檢測，對於臨床所使用的材料在應力分布分面的研究上有其優越性，已廣泛的應用於牙醫學研究中。因此本研究以改變聚乳酸製程時加熱溫度與加熱時間爲控制變因，將光彈檢測所觀測之現象，與聚乳酸基本材料性質之分子量、結晶度、機械強度等參數相互比較，評估以光彈檢測作爲聚乳酸品質監控參數的可行性，經實驗發現當聚乳酸製程參數改變時，光彈檢測下所反映出內應力條紋分布狀態變化情形與聚乳酸高分子之基本性質如分子量、結晶度等改變的趨勢均相似。因此進一步研究後，利用光彈檢測找出聚乳酸之最佳製程條件，以及消除應力之方法，提高製成品強度是可預期的。並可在未來將光彈檢測非接觸、非破壞性的特性，作爲生產線上產品之品質管制（ＱＣ）的最佳工具之一。
關鍵辭：聚乳酸、光彈檢測法、結晶性、熱性質、彎曲模數

英文摘要

Thermal degradable polymer (e.g. polylactic acid) is characterized by its photo-elasticity. During the polymerization process, its crystallization and mechanical properties are critically affected by temperature, pressure and other processing condition. Whether the magnitude and location of the residual stress inside a polymer

are also affected by the processing conditions is unclear. This study used polymerization of lactic acid into #20 (pure PLLA) and #30 (95% PLLA and 5% PDLA) under different processing conditions (e.g. heating temperature, heating time) as experimental model. Photoelastic analysis apparatus,MTS, were used to examine the distribution of residual stress inside the polymerized product and its relationship with the breaking point; X-ray diffractometer and Gel Permeation Chromatography were used to examine the relationship between crystallization, molecular weight and distribution of residual stress. The results showed a non-linear log regression in stress (i.e.no.of fringe order) of #20 and #30 under different processing temperature. The fringe order in #20 was gradually reduced with the processing temperature increasing from 170°C to 190°C, indicating a degradation of PLLA and a reduction of internal stress under higher temperature. The stress in #30 was however the lowest at a processing temperature of 160°C when the temperature was increased from 150°C to 170°C. These results suggest that photoelastic analysis is a convenient and non-invasive technique that can be used to accurately examine the internal stress of a polymer product. It can be used as an important indication for the best processing procedure for high-molecule injection processes and quality control of the products.
Key words: PLA, photoelastic analysis, crystallnility, annealing, Bending modulus