以電氣紡絲製備具奈米結構之生物分解性薄膜

Fabrication of nanostructured biodegrdable membrane via an electrospinning process

中文摘要

本研究主要是以電氣紡絲之技術爲手段，以 Poly-L-lactic acid(PLLA)、Poly butylene succinate-co-adipate(PBSA)、chitosan 等高分子爲溶質，CH2Cl2、CHCl3、H2O、EtOH 等溶液爲溶劑所構成的溶液製備具備奈米結構之薄膜以作爲 GTR 或 GBR 用薄膜。首先，是以高壓直流變壓器所產生的高電壓(約 10-50kV)爲驅動力，利用物理性質的高壓電場差，將溶解高分子溶液經毛細管射出，形成一道飛行軌跡(jet)，再經高電壓導致的拉伸及分裂(splay)後，飛行至鋁板蒐集區而形成不織布(non-woven)型態之薄膜薄膜，再利用電場電壓、溶液濃度、供液速率條件的控制，以製備各種不同纖維直徑、孔徑、孔洞率、尺寸及厚薄的薄膜。從所得薄膜的分析結果中發現，纖維直徑與射出電壓應成一反比關係，纖維直徑與溶液濃度應成一正比關係，最細可達 100 nm 左右，而膜的強力與電壓強度成反比但與膜厚無關，其強力最高可達 6.34MPa。膜厚則與供液速率成一正比關係，而濃度在 10~12wt%間則會有較佳的射出結果，推測和溶液之粘彈性有相當的關係。經由電氣紡絲過程所得之生物降解性薄膜，其孔洞大小能精準備控制，最小孔洞能達 10 μm 以下，且分佈集中率高達 95%以上。實驗中亦發現 PLLA 與 PBSA 能均勻地混合，且同時能控制單一成分的纖維尺寸及型態，亦能控制其組成比率。同時經由 DSC 熱分析及 X-ray 繞射測試發現，電氣紡絲過程不會改變或影響高分子之結構及物化性質。在離體實驗中亦發現，小直徑纖維降解應該與纖維直徑及膜孔大小有關，直徑愈小降解發生時間較晚，但降解速率較快，而膜孔愈大降解愈快，同時發現其薄膜能在 PBS 緩衝溶液中支撐最少 5 週時間，其符合臨床隔離膜或組織再生膜之要求。

英文摘要

The major purpose of this study is to fabricate a nanostructured Biodegradable non-woven membrane using ElectroSpinning technology from biopolymers. In this study, 5-20wt% polylactide or/and polybutylene succinate-co-adipate solution were prepared to produce some kind non-woven membranes. The polymer solution was feed by an infusion pump to a capillary which connect with direct current power supplier. 0.17~5.1ml/min of feeding rate were applied. A positive high-voltage direct current supplier was used to generate a voltage about 0—30 kV as a driving force. The collector was grounded, and the distance between capillary and collector was fixed in 15 cm. Practically, certain conditions such as DC voltage and solution concentration were finely controlled to investigate the physical, chemical and

biological properties of the membranes. Besides the obtained membrane evaluated its physico-chemical properties, and polarizing microscope, electron microscope was used to observe its morphology. Upon voltage, the fiber diameter, the membrane strength and the voltage have the inverse ratio also thick has nothing to do with the membrane were found, but strength most reaches as high as 6.43MPa. Upon concentration, solution can not start to splay when the concentration is lower than 7.5%, oversized is unable to splay when the concentration is higher than 20%, and best polymer soultion concentration for electrospinning is 10~12wt%. The membrane pore size almost can be finely control near 10μm, and also the pore size distribution is over 95%. The caliber size and the fiber diameter become the direct ratio relations upon capillary diameter were found next. PLLA and PBSA could evenly mixed were found in final, and that the fiber diameter and morphology of single component could be control were also found simultaneously. In in vitro study, the membrane released lactic acid in to PBS solution after 5 weeks. Totally, the size and structure of bioabsorbable membrane can be controlled finely via a micro adjustment in jet conditions, and different bioabsorbable polymers which more than 2 kind could be uniformly mixed in nano-scale simultaneously; furthermore, future might as the GTR(guided tissue regeneration) or GBR(guided bone regeneration) membrane for periodontal use.