聚乳酸薄膜及複合材之機械性質研究

Mechanical properties of polylactide films and composites

中文摘要

聚乳酸是一種良好的骨接合固定裝置材料,它具有良好的生物相容性及機械性質,且在體內可被吸收代謝等優點,因此毋需進行二次移除手術;另一方面,一般合成不易得到超高分子量的聚乳酸,導致機械性質亦受影響,而無法適用於體內必須承受較大應力的骨折處,此為其臨床應用上的一大缺失.本研究中,先將聚乳酸製成薄膜,浸泡於磷酸緩衝溶液(PBS)中 0,1,3 週,再將各薄膜試樣進行拉伸試驗,觀察,分析拉伸過程所產生的變形區,以瞭解其破壞行為與活體外退化情況,作為改良聚乳酸機械性質的知識基礎;再以壓縮模具技術依不同加工條件將含 0,10wt% ,30wt% ,50wt% 氫氧磷灰石的聚乳酸製成 40*4*3mm^3 的塊狀試樣,進行機械性質,熱性質,分子量,斷面形態觀察等各項物理性質的探討.

研究結果顯示聚乳酸薄膜的破壞行為屬於脆性破壞;而無論薄膜是否浸泡過 PBS,並不影響本身的降伏強度,但未浸泡的薄膜具較差的機械穩定性;結晶薄膜與非結晶薄膜的降伏強度無明顯差異,但結晶薄膜變形區孕核首先發生在晶界間的非結晶區域.在複合材塊狀試樣部份,氫氧磷灰石含量愈高,彎曲強度愈小,彎曲模數愈高,所含聚乳酸之結晶度愈小,但複合材的玻璃轉化溫度與熔點則無顯著改變;含氫氧磷灰石比例相同時,氫氧磷灰石顆粒愈大者,彎曲模數愈小,所含聚乳酸之結晶度愈大,而複合材的玻璃轉化溫度與熔點亦無顯著改變;以掃瞄式電子顯微鏡觀察斷面形態,發現氫氧磷灰石／聚乳酸複合材為混合式斷裂,在高含量氫氧磷灰石試樣中,氫氧磷灰石與聚乳酸界面間存在有空隙,其結合性不佳,可能為機械性質降低的原因.

英文摘要

Poly-L-lactide(PLLA)is an excellent osteosynthesis material because it has good biocompatibility and it can be metabolized completely in humam body. On the other hand, commercial PLLA with a high molecular weight, over 5*10^6, was difficult to make, resulting in limited mechanical properties and an insufficient application in stress-bearing fracture sites. In this study,first, PLLA film samples were made of commercial available PLLA, and immersed in phosphate buffer solution(PBS) for 0, 1, and 3 weeks. After stretching, the deformation zones of the film samples produced during the stretching process were observed and analyzed to investigate the micro-deformation behavior of PLLA. Then, PLLA reinforced with 0,10wt%,30wt%,50wt% hydroxyapatite(HA) was fabricated into a block(40*3*4 mm^3) using a compression molding technique under several processing conditions. The composite samples were tested by material testing system, differential scanning calorimetry and gel permeabilitychromatography, and the morphology of the fracture surfaces were observed by ascanning electronic microscope to investidate their physical properties.The results show that the PLLA film samples were deformed by crazing rather than shear. During 3 weeks, no matter whether the film samples immersed in PBS or not, the yield strength of the film samples was not affected. There were no significant differences between the yield strength of crystal and non-crystal film samples, but the nucleation of the deformation zone of the crystal film samples happened in the non-crystal areas first.The flexural strength and the crystallinity of PLLA composite samples decrease as the HA contents increased, while the Young''s modulus was reversed. When the HA contents are the same, the Young''s modulus decreased as the HA particle size became larger, while the crystallinity of PLLA in the samples was reversed. The morphology of the fracture surfaces of the samples shows that the fracture of HA/PLLA composites is a mix-type fracture, and the space between HA nad PLLA interface becomes larger as the HA contents increase. The decreasing bonding strength between HA and PLLA might be the reason for a decrease in flexural strength.