球磨處理對生醫用多孔鈦合金性質之影響研究

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摘 要

近年來最常被研究探討的多孔金屬材料即是鈦金屬及其合金，因為鈦及其合金具有極佳的生物相容性與生物活性以及較低的彈性模數，由於具有以上這些優良的性質，因此，鈦金屬及其合金已被普遍應用於生醫材料上。 本實驗目的針對TiMo合金系統中，將純元素Ti與Mo粉末故藉由機械合金法(mechanical alloying, MA)，以達到非晶質之合金粉末。並利用碳酸氫氨(NH4HCO3)作為成孔劑，而本研究中成孔劑之所以選擇碳酸氫氨(NH4HCO3)，其原因是碳酸氫氨具有低熔點之特性故在脫除上較為簡易。本實驗將不同球磨處理時間，分別以BM3、BM15、BM30表示。經由背向式電子顯微觀察發現，在BM3處理後，粉末尚未達到均質化，再經過BM15及BM30之處理後，粉末以達到均質化階段。將球磨過的合金粉末進行多孔TiMo支架的製作，並利用真空熱處理爐進行真空燒結，真空度為D1 Pa，燒結溫度至A1 ℃並分別持溫B1、B2、B3及B4小時。 在XRD相分析方面，多孔TiMo合金經過不同燒結階段後，並無任何純元素鈦及鉬的存在，同時此時將會產生新的合金相β-(Ti, Mo)。在抗壓強度方面，本實驗以不同的持溫下製作出多孔TiMo支架分別為B1、B2、B3及B4小時，結果提出，隨著燒結時間的增加，有助於提高多孔TiMo支架之抗壓強度，並配合抗壓強度之結果，本實驗選擇BM15之合金粉末以及燒結B1小時之多孔樣品作為後續表面改質之研究，因此組條件之抗壓強度及彈性模數分別為25.02 MPa, 1.72 GPa，非常適合鬆質骨植入材之應用。 另外在孔徑分佈方面，不同球磨時間以及不同燒結階段之多孔樣品皆以100-200 μm之孔徑居多，但在第BM30之處理後，由於粉末的粒徑分佈趨向均一，在模壓成形後，導致粉末與粉末之間會有孔隙存在，進而影響孔徑大小之差異。因此在BM30處理後之多孔樣品，我們可以清楚的看到在400 μm以上之孔徑有明顯變多之趨勢。 多孔試片經由表面改質(鹼處理及鹼水處理)後，發現試片表面將會形成一網狀多孔結構，藉由HR-XRD分析顯示為Na2Ti6O13鈦酸鈉水凝膠層(sodium titanate hydrogel)，且經FE-SEM觀察發現鹼水處理的網孔比鹼處理來的小，然而為了觀察孔洞對磷灰石生成的影響故以實心試片作為對照組。隨後將實心及多孔試片進行人工模擬體液(simulated body fluid, SBF) 之浸泡，其結果顯示鹼處理及鹼水處理後之多孔試片於SBF-14天的浸泡中發現孔洞內部已開始生成磷灰石。而後續觀察浸泡21天，發現鹼處理及鹼水處理之多孔試片，不論是孔洞內及孔洞外皆以佈滿磷灰石，而後續經由EDS分析發現，不論是鹼處理及鹼水處理Ca與P的含量相當高。由此結果得知，多孔TiMo支架經由表面改質後對於多孔植入材而言具有良好的生物活性。

關鍵詞 : 機械合金法、多孔鈦合金、多孔金屬材料、粉末冶金、力學性能、表面改質、生物相容性、生物活性

目錄

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