固相燃燒合成鈦鎳與鎳鋁界金屬之實驗研究

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摘 要

本研究係以自持傳遞高溫合成法（Self-propagating High-temperature Synthesis, SHS）於氬氣環境下燃燒合成鈦鎳形狀記憶合金（NiTi Shape Memory Alloys, NiTi SMAs）、鎳鋁介金屬（Ni3Al Intermetallic）及添加硼粉之鎳鋁介金屬（Ni3Al+B）等介金屬複合物，探討其燃燒反應之特性，研究不同粉末粒徑、試片密度、預熱溫度對於其火焰烽面傳遞速度（Flame-Front Velocity）、燃燒溫度(Combustion Temperature)及產物轉換率（conversion）之影響。實驗結果顯示出此三種介金屬之火焰烽面皆以平整之模式向下傳遞；除鎳-鋁介金屬表3第一組及第二組之低初始密度於反應後試片有微量膨脹外，其它燃燒反應皆具有收縮之現象。火焰烽面傳遞速度會隨試片密度及預熱溫度上昇而增快，三種材料燃燒反應之火焰烽面傳遞速度中，以鎳-鋁-硼反應最快，鈦-鎳反應次之，鎳-鋁反應最慢，而隨著粉末粒徑的改變火焰烽面傳遞速度亦有增加之趨勢；鎳-鋁-硼反應之速度亦隨硼粉含量而成倍數成長；依反應材料之不同，火焰烽面傳遞速度約介於 5.5 ~ 121 mm/s 之間。而藉由火焰烽面傳遞速度與燃燒溫度，計算出鎳-鋁之SHS反應之活化能（Activation Energy）介於為92.06 ~ 97.78 kJ/mole；而鎳-鋁-硼之SHS反應之活化能為86.4 kJ/mole。產物之X光粉末繞射分析（X-Ray Diffraction, XRD）結果顯示出產物轉換率主要受到粉末粒徑、試片密度及預熱溫度之影響，而粒徑愈小、密度愈大、預熱愈高之試片於反應過後產物合成情形愈佳，但鈦-鎳反應在粉末粒徑、試片密度及預熱溫度皆處於最佳條件下，產物裡仍含有二次相產物及未反應之金屬如：NiTi2和Ni3Ti之中間產物；鎳-鋁反應及鎳-鋁-硼反應在最佳條件下反應後，產物中則皆為其欲合成之產物，轉換率達到百分之百。而掃描式電子顯微鏡（Scanning Electron Microscope, SEM）所攝得之顯微結構照片則顯示出於鈦-鎳反應之產物中存在著孔隙及密實之顯微結構；鎳-鋁-硼反應之較為密實之顯微結構。

關鍵詞 : 鈦鎳形狀記憶合金，鎳鋁介金屬，添加硼粉之鎳鋁介金屬，自持傳遞高溫合成，二次燃燒，火焰烽面，活化能，預熱

目錄

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