自持性燃燒合成鈷鋁、鈷鈦與鈦矽介金屬之研究

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摘 要

本研究係以自持性燃燒合成法（ Self-propagating High-temperature Synthesis, SHS），在氬氣環境下進行燃燒合成之 鈷鋁（CoAl）、鈷鈦（CoTi）及鈦-矽（Ti-Si）介金屬。其研究包 含了兩大部分；第一部分探討鈷鋁及鈷鈦試片在不同的最大理論 密度(TMD)和不同的預熱溫度(Preheating)對其火焰鋒面傳遞模 式、火焰鋒面傳遞速度（Flame-Front Velocity）、產物轉換率以及 產物密度之影響。第二部分則研究各種莫爾比例的鈦-矽介金屬， 觀察其燃燒合成之產物並探討不同比例對其燃燒溫度及火焰傳遞 速度的影響。 而第一部分的實驗結果發現兩種材料之燃燒鋒面皆以一個平 整的形式向下傳遞，另外鈷鈦燃燒反應有二次燃燒的現象。當鈷 鋁及鈷鈦試片的理論密度越大時，火焰鋒面傳遞的速度也隨之加 快；而在鈷鈦系統中，當預熱溫度越高時其火焰鋒面速度有增快 的趨勢，而在鈷鋁系統中，預熱溫度及粉末粒徑大小只有在較低 的試片密度條件下之影響才較為明顯。而產物轉換率方面，經由 X 光粉末繞射分析(XRD)，發現鈷鋁及鈷鈦的產物轉換率都幾近乎100%。而根據實驗數據之燃燒溫度及火焰鋒面速度可歸納出 鈷鋁介金屬（CoAl）反應之活化能為121.69 kJ/mole，鈷鈦介金 屬（CoTi）為67.95 kJ/mole。 而第二部分的實驗為觀察不同比例的燃燒特性，而由燃燒方 面觀察，每種比例的鈦-矽介金屬皆以一平整的火焰鋒面向下傳 遞，而在試片密度較低時，燃燒鋒面過後會有噴濺的現象；由燃 燒溫度觀察，除了Ti：Si = 1：2 之外，大部分的組態皆超過鈦- 矽共熔溫度1330 ℃；而火焰鋒面速度在組態為5：3、3：2 及5： 4 最快，大約為20~60 mm/s 左右，而比例為1：2 最慢，約為3~5.3 mm/s 左右。所以可推斷比例為1：2 之燃燒鋒面是以固相與固相 間反應為主，所以傳遞速度較慢；而組態5：3、3：2 與5：4 反 應時會產生共熔液，所以燃燒鋒面則以液相與固相間反應為主， 所以傳遞速度較快。而Ti-Si 的產物較為複雜，其中組態為5：3 與3：2 產物轉換最好，皆可生成Ti5Si3，其次為組態1：2，其主 要生成物為TiSi2，而組態5：4 及1：1 則會同時生成兩者或兩者 以上的介金屬（TiSi、Ti5Si4、Ti5Si3）。而根據火焰鋒面傳遞速度 與燃燒溫度之結果，可推斷鈦-矽介金屬（Ti5Si3）為205.21 kJ/mole。

關鍵詞 : 自持傳遞高溫合成 ; 鈷鋁介金屬 ; 鈦-矽介金屬

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