探討置換型式與元素間之燃燒合成於金屬硼化物的製備

王竑傑、吳佩學 ; 葉俊良

E-mail: 9805374@mail.dyu.edu.tw

摘 要

本研究主要是探討利用燃燒合成技術嘗試生成不同金屬硼化物（Ta-B、V-B、Cr-B、Nb-B、W-B）之可能性，實驗分為二大部份：第一部份為單純利用純元素粉末，針對不同組態進行實驗；第二部份則為使用金屬氧化物，藉由置換反應形式進行試驗，並針對不同硼含量的變化作探討。並且在實驗結果分別對於火焰鋒面傳遞模式及速度、燃燒溫度以及生成產物之影響作為探討。

實驗第一部份則是觀察不同莫爾比之鉭硼(Ta-B)化物及釩硼(V-B)化物，鉭硼化物部份其固相火焰觀察則觀察到其火焰鋒面皆是以螺旋火焰鋒面向下傳遞，並且火焰鋒面傳遞速度及燃燒溫度得知整體速度為4～11.7 mm/s、燃燒溫度則約1200～1750℃。組態為Ta：B＝1：1時速度為最高約10.3～11.7 mm/s、燃燒溫度為1750℃，而組態2：1則最慢速度約4 mm/s、燃燒溫度約為1200℃。產物組成方面，組態Ta：B＝1：1及1：2皆生成單相產物TaB及TaB2，並計算出活化能約187.7 kJ/mol及96.7 kJ/mol，而其他組態則生成多相產物Ta2B、TaB、TaB2、Ta3B4以及些許鉭元素殘留。釩硼化物部份其固相火焰反應模式則會隨著初始溫度的變化而改變，在初始溫度為100℃時火焰鋒面皆是以螺旋方式傳遞，而當初始溫度為200℃以上時所有組態皆以平整穩態火焰傳遞。組態為V：B＝5：6時火焰鋒面傳遞速度為最高約26 mm/s，而組態1：2則為最低約2 mm/s，整體燃燒溫度則約介於1470～1600℃之間。產物組成部分，組態V：B＝3：2、1：1、5：6及3：4皆生成單相產物VB，而組態2：3、1：2則生成多相產物VB、V3B4、VB2。

第二部份為藉由金屬氧化物進行置換反應生成鈮硼(Nb-B)化物、鉻硼(Cr-B)化物、鎢硼(W-B)化物。鈮硼化物其反應範圍在Nb2O5：B＝1：5～1：10之間，火焰鋒面則是以平整穩態傳遞，而火焰鋒面傳遞速度則是在比例為1：8.5時最高約3.9 mm/s，而1：5則為最慢約1.75 mm/s；燃燒溫度則是在比例1：8.5及1：9時為最高，約介於1300～1380℃之間，而比例1：5則為最低約1050℃。產物生成則在比例為Nb2O5：B＝1：9及1：10生成單相產物NbB2，而其他比例則生成多相產物NbB、Nb3B4以及些許金屬氧化物殘留。鉻硼化物反應範圍在Cr2O3：B＝1：4～1：9，火焰鋒面以穩態傳遞，火焰鋒面傳遞速度則在比例為1：6時為最高約2.7 mm/s而最慢則在比例為1：4約0.9 mm/s，整體燃燒溫度約在705～828℃之間。產物組成則無法生成單相產物，僅有在1：9時能生成較接近單相產物CrB2，其他比例下則生成多相產物CrB、CrB2、Cr5B3。鎢硼化物在不同硼含量下添加鎢參與反應，其反應範圍在WO3：B：W＝1：6、7、7.5：0.5～2.3，火焰鋒面則是以螺旋火焰傳遞，傳遞速度及燃燒溫度則可以明顯看出隨著鎢的添加而降低，約介於1.5～3.2 mm/s及1300～1550℃之間。產物組成則生成多相產物W2B、WB、WB2、WB4及些許鎢。

綜合以上結果，在燃燒合成金屬硼化物的探討中，得到藉由元素間的反應或者搭配金屬氧化物來參與反應合成的結果。而在產物的生成方面，則歸納出單硼化物(MB)及二硼化物(MB2)的相最容易生成。

關鍵詞 : 燃燒合成、金屬硼化物、置換反應

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