利用自持傳遞高溫合成製備先進陶瓷複合材料

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摘 要

本文主要探討利用自持傳遞高溫合成法 (Self-Propagating High-Temperature Synthesis,SHS)燃燒合 成先進陶瓷複合材料；實驗中藉由影像與資料擷取系統可得到試 片於反應過程中火燄鋒面傳遞模式、傳遞速度與火燄鋒面燃燒溫 度之數據，並透過絕熱溫度之計算配合火燄鋒面燃燒速度和溫度 相互驗證而比較趨勢之準確性；此外，於實驗前後可分別量測反 應物與產物之重量，進而求得產物之氮化率，最後再利用XRD產 物分析得知產物中之成分並透過SEM進行產物微結構之觀察。本實驗第一部分為反應試片在氬氣的環境下，藉由碳化硼(B4C)添 加鈦(Ti)、鉭(Ta)、碳(C)、矽(Si)或硼(B)進行固相與固相之燃 燒反應合成硼化鈦-碳化鈦(TiB2-TiC, TiB-TiC)、硼化鈦-碳化矽 (TiB2-SiC)與硼化鉭-碳化鉭(TaB2-TaC,TaB-TaC)五種陶瓷複合材 料。實驗結果顯示，當合成產物為TiB2-TiC與TiB2-SiC時，其火 燄鋒面皆以一平整穩定的方式向下傳遞，並有膨脹的現象產生， 而火燄鋒面傳遞速度和溫度隨著TiB2含量增加至66.67%時均有上 升的趨勢，且燃燒溫度亦同。在產物分析方面，除了主要產物之 外，均無中間產物生成。若於試片中添加少許的Ni，則會有中間 產物如Ni3Ti、TiB生成以及少許未反應之Ni殘留，另外還有些微 的固溶體NiTi生成。當合成產物為TaB2-TaC時，其火燄鋒面亦以 一平整穩定的方式向下傳遞，但其膨脹現象較不明顯，且火焰鋒 面傳遞速度有下降的趨勢，最低可達5.07mm/s，而燃燒溫度均介 在1400℃上下。在產物分析方面，當試片中另外添加硼粉時，除 了主要產物TaB2和TaC之外，還會有中間產物TaB、Ta5B6生成。本實驗第二部分為在氮氣(2.17MPa)環境下進行燃燒合成賽隆陶 瓷(α+β)-SiAlON之實驗研究，並觀察氧化鐿(Yb2O3)、矽(Si)、 氮化矽(Si3N4)、二氧化矽(SiO2)和鋁(Al)五種反應物依不同比例 下所合成產物的特性，其試片組成Si:Si3N4分別為2.5:1、3:1和 3.5:1。實驗結果顯示，於燃燒過程中因兩個燃燒源之反應區域互 相交錯，而使燃燒鋒面以混沌且不具規則性之方式向下傳遞，而 當反應物中只含β-Si3N4粉末時，其混沌現象則較不明顯。在火 燄鋒面傳遞速度方面，因鋒面之不規則跳動，所以平均速度均介 在0.8~1.1 mm/s之間，並無明顯的趨勢產生。在燃燒溫度方面， 其鋒值約介於1200~1400℃之間。在產物轉換率方面，當試片中 α-Si3N4粉末含量高達100%時，其Si的殘留有明顯增加的現象產 生。在氮化百分率方面，若試片中α-Si3N4粉末增加時，產物會 有較高的氮化率表現。透過SEM顯微結構之觀察，(α+β)-SiAlON 之微結構為片狀與瘦長柱狀且稍透明的晶體結構。

關鍵詞 : 自持傳遞高溫合成、碳化硼、賽隆、氮化矽、XRD、火燄鋒面傳遞速度、氮化率。

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