探討氮化硼與氮化矽於燃燒合成含金屬氮化物複合材料之實驗研究

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摘 要

本實驗研究係用以自持性傳遞高溫合成法(Self-propagating High-temperature Synthesis, SHS)進行燃燒反應合成，並且在組成中利用氮化硼(Boron Nitride)與氮化矽(Silicon Nitride)為 反應物燃燒合成氮化鈦/二硼化鈦(TiN-TiB2)、氮化鉭/硼化鉭(TaN-TaB)以及氮化鈦/矽化鈦(TiN- Ti5Si3)等含金屬氮化物之複合材料，其中BN及Si3N4可提升在固態來源中金屬氮化物的形成。 在本研究的第一部份中，運用兩種系統的製成方式來反應合成複合材料(TiN-TiB2)，一為在組 成上搭配Ti和BN粉末的比例在氮氣壓力下反應，以燃燒合成TiN所佔比例為75~87.5之莫耳百分比的 複合材料，另法則是在實驗中搭配組成Ti/BN/B在氬氣下反應，使其有足夠的硼成份反應合成50~75 之莫耳百分比的TiB2，由於在以往的反應系統中皆是固相與氣相間的反應，並且試片的孔隙度與稀 釋劑TiN對於產物氮化率有明顯的影響，反之，組成上的改變在燃燒合成後易影響試片的結構。由 實驗結果顯示，組成為(1.5Ti+BN)在氬氣下反應時，可完全轉換至(TiN/TiB2=67/33)之莫耳比，並且證實BN確實是可完全分解反應生成TiN及TiB2，另外在1.48MPa的氮氣壓力下包括無添加稀釋劑的 組成(2Ti+BN)、60%之試片最大理論密度(Theoretical Maximum Density, TMD)、可直接生成75之莫 耳百分比的TiN，以及在相同60%TMD下需添加稀釋劑之組成中能完全轉換高達83或87.5之莫耳百分比 的TiN含量。 在本研究的第二部份中，運用兩種方式來製成(TiN-Ti5Si3)之複合材料，一種是利用氮化矽 (Si3N4)作為固態燃燒系統裡氮的固態來源，另一種則是運用Ti與Si粉末在氮氣壓力下反應，在Ti與 Si3N4及Ti-Si3N4-Si之兩種固態燃燒反應系統下，能有效地生成(TiN-Ti5Si3)之產物比例可由20~80之莫耳百分比。此結果證實了Si3N4對於生成(TiN-Ti5Si3)之貢獻。不過，在Ti與Si於氮氣下靠固相 與氣相的反應中，由實驗證實是個不理想之方法，對生成TiN而言，例如以80之莫耳百分比來說，發 現Si與氮氣之間的反應不甚良好，反之，像20或甚至50之莫耳百分比一樣僅有低含量的TiN合成 (TiN-Ti5Si3)，並且有中間產物TiSi2及Si殘留。 在本研究的第三部份中，嘗試進行(TaN-TaB)之複合材料，發現反應物BN於低氮氣壓力下皆反應 不完全，因此，在最後的產物觀察分析中，有Ta2N的中間產物生成，及一些未反應的Ta、BN殘留。故 透過此研究建議，在燃燒反應(TaN-TaB)中，其BN的利用獲益不及(TiN-TiB2)來的好。

關鍵詞 : 自持傳遞高溫合成，氮化鈦/二硼化鈦，氮化鉭/硼化鉭，氮化鈦/矽化鈦，二次燃燒，稀釋劑

目錄

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