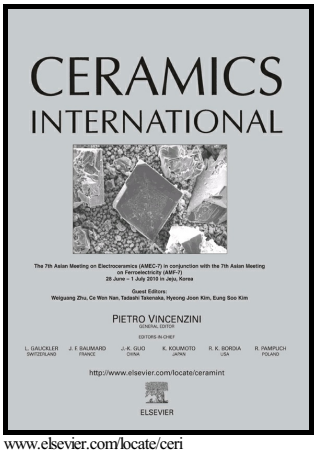

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Optimization of spark plasma sintering parameters of Si_3N_4-SiC composite using response surface methodology (RSM)

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Abstract

The Si_3N_4-SiC micro-nano composites were fabricated via the spark plasma sintering method using $MgSiN_2$ as an additive. Response surface methodology and central composite design were applied to optimize the spark plasma sintering process for the fabrication of Si_3N_4-SiC/$MgSiN_2$ with improved density. The relation between the three parameters of sintering including temperature, pressure, and holding time was modeled and the optimized parameters were obtained. The best sintering results obtained for the sintering temperature, holding time, and pressure are 1700℃, 487s, and 49 MPa, respectively. The addition of $MgSiN_2$ as an additive and SiC as a secondary phase were also investigated in the present work. The Si_3N_4-5 vol.% SiC composite exhibited high hardness (19 GPa) and fracture toughness values (6.5 $MPa.m^{1/2}$) at room temperature.

Keywords: silicon nitride; composite; Response surface methodology; spark plasma sintering

1. Introduction

Reinforced ceramic matrix composites have found many high-temperature applications such as in turbines, automobile engine components, heat exchangers, and refractory materials [1]. Si_3N_4-based composites are among the interests in engineering applications such as gas turbines, engine core components, and cutting tools because of their favorable mechanical properties at high temperature, resistance to oxidation and