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S. Bahrami, M. Zakeri, A. Faeghinia, M.R. Rahimipour



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Spark Plasma Sintering of Silicon Nitride/Barium Aluminum Silicate Composite

S. Bahrami, M. Zakeri*, A. Faeghinia, M.R. Rahimpour

Ceramic department, Materials and Energy Research Center, Karaj, Iran

*Tel.:+98(26)36204131; fax: +98(26)36201888. m_zakeri@merc.ac.ir

Abstract

Si₃N₄ based composites were successfully sintered by spark plasma sintering using low cost BaCO₃, SiO₂ and Al₂O₃ as additives. Powder mixtures were sintered at 1600 to 1800°C for 5 and 10 min. Displacement-temperature-time (DTT) diagrams were used to evaluate the sintering behavior. Shrinkage curve revealed that densification was performed between 1100-1700°C. The specimen sintered at 1700°C showed the maximum relative density (99.8±0.1%), flexural strength (352±16MPa), Vickers hardness (11±0.1GPa) and toughness (5.6±0.05MPa.m^{1/2}).

Keywords: Silicon nitride, Spark plasma sintering.

1-Introduction

Advanced ceramics have been developed for a number of commercial and industrial applications, including turbine engines, reciprocating heat engines, waste incineration, electronic packaging, armor, cutting tools and missile radomes [1]. Among the advanced ceramics, Si₃N₄ has shown excellent mechanical, physical and chemical properties. Therefore, it has been considered as a promising wave-transparent material to be used in high temperature environment and radomes with high supersonic and hypersonic speeds [2].

There are two well-known phases of silicon nitride, α and β both having hexagonal structure. α -Si₃N₄ is thermodynamically stable at low temperatures and it irreversibly transforms to β at high temperatures [3]. Richardson et al. reported that α to β transformation cannot be completed during pressure-less sintering at 1800°C for 7h because of its slow reaction rate [4]. Therefore, researchers have proposed using spark plasma sintering to promote α to β transformation at short time. Spark plasma sintering (SPS) is a powerful technique for sintering of silicon nitride at lower temperature and

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