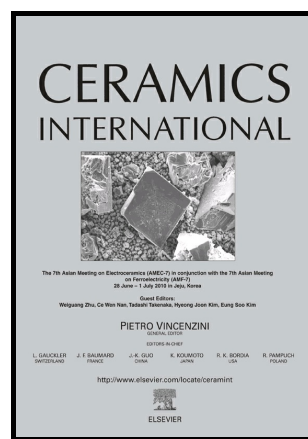


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Sintering

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Preparation and Characterization of Si₃N₄-based Composite Ceramic

Tool Materials by Microwave Sintering

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Abstract: Si₃N₄-based composite ceramic tool materials with (W,Ti)C as particle reinforced phase were fabricated by microwave sintering. The effects of the fraction of (W,Ti)C and sintering temperature on the mechanical properties, phase transformation and microstructure of Si₃N₄-based ceramics were investigated. The frictional characteristics of the microwave sintered Si₃N₄-based ceramics were also studied. The results showed that the (W,Ti)C would hinder the densification and phase transformation of Si₃N₄ ceramics, while it enhanced the aspect-ratio of β -Si₃N₄ which promoted the mechanical properties. The Si₃N₄-based composite ceramics reinforced by 15wt.% (W,Ti)C sintered at 1600°C for 10 min by microwave sintering exhibited the optimum mechanical properties. Its relative density, Vickers hardness and fracture toughness were $95.73 \pm 0.21\%$, $15.92 \pm 0.09\text{GPa}$ and $7.01 \pm 0.14\text{MPa}\cdot\text{m}^{1/2}$, respectively. Compared to the monolithic Si₃N₄ ceramics by microwave sintering, the sintering temperature decreased 100°C, the Vickers hardness and fracture toughness were enhanced by 6.7% and 8.9%, respectively. The friction coefficient and wear rate of the Si₃N₄/(W,Ti)C sliding against the bearing steel increased initially and then decreased with the increase of the mass fraction of (W,Ti)C., and the friction coefficient and wear rate reached the minimum value while the fraction of (W,Ti)C was 15wt.%.

Key words: Si₃N₄/(W,Ti)C ceramics; microwave sintering; mechanical properties; microstructure; frictional characteristics

1 Introduction

Silicon nitride ceramic attract more attention at present for its excellent mechanical properties [1], good wear resistance [2] and thermal shock resistance [3]. For the excellent properties of Si₃N₄ ceramics at both room and high temperatures, they have been widely used as structural applications, such as heat insulators, gas turbines and cutting tools, etc.

However, the applications of silicon nitride ceramic materials are not as widespread as they might be due to their relatively low hardness and poor fracture toughness. For improving mechanical properties of Si₃N₄ ceramics, much effort has been made in the fabrication of silicon nitride ceramics by conventional sintering

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