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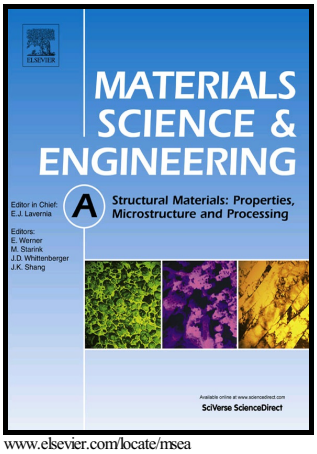

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Investigation on mechanical properties and microstructure of silicon nitride ceramics fabricated by spark plasma sintering

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Abstract:

In order to prepare high-performance and stable performance silicon nitride-based ceramic cutting tools, orthogonal experiment was carried out firstly to study the influence of sintering temperature and sintering aids ($MgSiN_2$, Y_2O_3 and CeO_2) on the densification and mechanical properties of the Si_3N_4 materials by spark plasma sintering. The results showed that Si_3N_4 ceramics with 5 wt%$MgSiN_2$, 3 wt%Y_2O_3 and 1 wt%CeO_2 sintering aids had the best relative density and mechanical properties at 1650 ℃. Secondly, the effects of sintering temperature on the densification, microstructure and mechanical properties of Si_3N_4 ceramics with 5 wt%$MgSiN_2$, 3 wt%Y_2O_3 and 1 wt%CeO_2 sintering aids were studied in detail. The results showed that the relative density of Si_3N_4 ceramics reached the maximum of 99.40±0.14% at 1650 ℃, the Vickers hardness and fracture toughness were 16.53±0.12 GPa and 6.89±0.20 MPa·$m^{1/2}$, respectively. The grain shapes were composed of equiaxed α-Si_3N_4 and long columnar β-Si_3N_4, and the transformation rate of α-Si_3N_4 to β-Si_3N_4 was 42.5%. Finally, the statistical distribution of the relative density, phase transformation rate and mechanical properties of Si_3N_4 ceramics with 5 wt%$MgSiN_2$, 3 wt%Y_2O_3 and 1 wt%CeO_2 sintering aids at 1650 ℃ was investigated. It was found that the mechanical properties of silicon nitride ceramics sintered by spark plasma sintering were less dispersive, and the hardness and fracture toughness obeyed the two parameters Weibull distribution well.