Fracture Toughness of SiC Whisker Reinforced Si_3N_4 Ceramics

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Fracture toughness for Si_3N_4 composite containing 0-30 wt% SiC whisker was measured by Indentation Microfracture (IM) and Chevron Notch (CN) methods. The results obtained by IM method showed that K_{IC}, calculated on the basis of Palmqvist-type crack, varied from 6.3 $MN/m^{-3/2}$ for the matrix Si_3N_4 to 7.2 $MN/m^{-3/2}$ for the composite containing 15 wt% whisker. On the other hand, K_{IC} obtained from CN method varied from 5.1 $MN/m^{-3/2}$ for the Si_3N_4 to 6.3 $MN/m^{-3/2}$ for the composite having 30 wt% whisker. These results indicate that fiber reinforcement with whisker is an effective way to toughen Si_3N_4 ceramics. Microscopic observations of the cracks induced by indentation showed that the crack propagation is often prohibited by the whisker, and that the crack is deflected to the interface between the whisker and the matrix. This crack deflection may be attributed to the stress fields set up at the interface, due to thermal expansion difference between the whisker and matrix. Considering such crack-whisker interaction, it is suggested that the dispersion of the whisker having larger diameter is effective in toughening Si_3N_4 ceramics.
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Properties of Plasma Sprayed CeO_2-ZrO_2-Y_2O_3 Thermal Barrier Coating

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The plasma sprayed CeO_2-ZrO_2-Y_2O_3 thermal barrier coating was developed, and thermal conductivity, thermal expansion, bending strength and hot corrosion resistance were evaluated. The results indicated that CeO_2-ZrO_2-Y_2O_3 compositions are useful for the plasma sprayed thermal barrier coatings. The thermal conductivity of the sprayed CeO_2-ZrO_2-Y_2O_3 coating was 1-2 $W/m \cdot K$, lower than that of sintered materials of the same composition and one of the lowest thermal conductivities of ceramics. Thus, the CeO_2-ZrO_2-Y_2O_3 coating is useful for the thermal barrier, since the sprayed layer is expected to insulate heat flow well. The thermal expansion coefficient of the sprayed CeO_2-ZrO_2-Y_2O_3 coating was $12 \times 10^{-6}/K$, comparable to that of the metal substrate $16 \times 10^{-6}/K$. The bending strength was 2-3 kgf/mm^2, favorable for the excellent thermal fatigue property. The hot corrosion resistance was almost the same as that of Y_2O_3-stabilized ZrO_2 thermal barrier coatings in a low vanadium environment.
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HIPing of Silicon Nitride with Additive of $BeAl_2O_4$

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Silicon nitride with a small amount of additive $BeAl_2O_4$ was sintered by HIP treatment in glass capsules. The sintered body of Si_3N_4 was for the most part β phase. $BeAl_2O_4$ dissolved into β-Si_3N_4 completely. The effect of isostatic pressure was significant in HIP sintering. For example, the bulk density of sintered body containing 3 wt% $BeAl_2O_4$ was almost theoretical, and its microstructure was homogenous when sintered above 1700°C and at an applied pressure 200 MPa.
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