material. The thermal conductivity of all RBSN samples decreased simply with increasing temperature due to the increase of the mutual scattering of the thermo-elastic wave, and the decreasing rate of thermal conductivity for the RBSN with lower α-contents was found to be larger than that for those with higher α-contents.
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Sintering and Vickers Hardness on Composite of Si_3N_4-SiC System

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The Si_3N_4-SiC composite (0 to 0.25 wt fraction of SiC) system was investigated to understand the effect of addition of one metal oxide (e.g. MgO, Al_2O_3, Y_2O_3 or CeO_2) and two metal oxides (e.g. Y_2O_3-Al_2O_3, CeO_2-Al_2O_3 etc.) on the sintering and Vickers hardness. The composites were hot-pressed at 1700°C under 400 kg·mm^{-2} or pressureless-sintered at 1700° and 1800°C. The results are as follows: The relative density of the composite decreased with the increasing of SiC content. The hot-pressed composites with 5 wt% Y_2O_3+10 wt% Al_2O_3 and 5 wt% CeO_2+10 wt% Al_2O_3 had 96 to 98% relative density and 1800 to 2000 kg·mm^{-2} Vickers hardness (at 5 kg load), and pressureless-sintered composites with 5 wt% Y_2O_3+10 wt% Al_2O_3 fired at 1700°C for 4 h had 87% relative density and 1200 kg·mm^{-2} Vickers hardness.
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Fatigue Test for HP-Si_3N_4 Ceramics Indented with Knoop Pyramid

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For controlling the scattering of fatigue life, four-point bending fatigue tests for hot-pressed silicon nitride ceramics indented with knoop pyramid have been carried out at room temperature. The scattering of fatigue life was controlled when test specimens were indented at 49 N load. The gradient of the S-N curve in the reversed bending fatigue test (tension-compression stress) was larger than that of the fluctuating bending fatigue test (tension-tension stress), and the fatigue life in the former was shorter than that in the latter at lower stress levels. Consequently it was concluded that crack propagation and/or degradation of mechanical properties was accelerated by the compression at lower stress levels. A slight difference was observed between the S-N curve for the indented specimens and that for the pre-loaded specimens. This disagreement was attributed mainly to the influence of residual stress generated by indentation. In order to estimate the residual stress, the specimens indented at 49 N load were either annealed in nitrogen gas (1300°C, 1 atm) or ground to remove surface layer, and fracture toughness for these specimens were calculated from room temperature bending strength and initial crack dimension. The residual stress levels at crack tip for the specimens indented at 9.8 N load and at 49 N load were about 70 MPa and 100 MPa, respectively.
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Effects of Some Additives on Microstructure and Bending Strength of Aluminum Titanate Ceramics

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Effects of four additives on the microstructure and bending strength of aluminum titanate ceramics were investigated. Five wt% of MgO, Fe_2O_3, Y_2O_3 and ZrO_2 was added to a synthesized aluminum titanate powder which had a particle size of about 1 μm. Firing temperature was 1300°, 1350° and 1400°C, and firing period was 2 h. The specimens were cooled in *the furnace. MgO and Fe_2O_3 dissolved into aluminum titanate as $MgTi_2O_5$ and Fe_2TiO_5, respectively. All specimens containing additives had crystalline phases besides aluminum titanate. In the specimens fired at 1300°C and containing ZrO_2, Y_2O_3, and no additive, corundum and rutile, decomposition products of aluminum titanate, were observed. Addition of MgO and Fe_2O_3 increased the sinterability of aluminum titanate, but addition of ZrO_2 decreased it. The grain size of aluminum titanate in fired specimens increased with increasing firing temperature, but decreased with the addition of MgO, Y_2O_3 and ZrO_2. Grain boundary microcracking during cooling due to the marked anisotropy of the aluminum titanate crystals increased with increasing firing temperature, and specimens containing MgO showed very little microcracking. Only MgO-containing specimens, especially those fired at high temperatures, exhibited transgranular fracture. These results suggest that the addition of MgO increases fracture surface energy of the grain boundary. Thus, the bending strength of MgO-added specimens was highest, 1850 kgf/cm^2 at 1350°C. Other specimens containing additives showed also higher bending strengths, about 500-800 kgf/cm^2 higher than blank specimens when fired at 1350° and 1400°C. The thermal expansion of the fired specimens containing MgO was about 0.7% at 1000°C, which was caused by very little microcracking during cooling.* [*Received October 4, 1985*]

Laser Machining of Hot-Pressed Silicon Nitride

Affected Layer by the Machining

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A plate of hot-pressed silicon nitride (HPSN), which is difficult to machine, was cut through by laser machining at the speed equal to that of usual slicing with a diamond wheel. Then the influences of laser machining on the strength and the composition of the material were investigated. The affected layer by laser machining was composed of three sites; site 1, melted granular materials sticked together, site 2, cracks were observed, and site 3, the residual stress existed without structural change. In the presence of this affected layer, the strength of the work decreased to one third of the strength of the material. From the changes of the strength caused by surface removal removing and the hardness in the cross section, the thickness of the affected layer that reduced the strength was estimated about 70 μm except site 1. But the change of the composition was observed only in boundary layer between site 1 and site 2 which was rich in yttria and alumina. Since an X-ray diffraction pattern showed that site 1 was composed of silicon, it was confirmed that silicon nitride was decomposed into silicon and nitrogen by laser machining. [*Received October 7, 1985*]

Surface Damage in Ground Silicon Carbide Ceramics

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Hot pressed (HP) and reaction bonded (RB) silicon carbide (SiC) ceramics were ground with a # 400 diamond wheel, and the induced damage was evaluated by the specimen strength measured by four-point bending test. The surface layers of the ground specimens were removed by polishing with a # 3000 diamond disc. The relationships between the strength and the thickness of removed layers were examined. In HP-SiC and RB-SiC, when the thickness was smaller than about 10 μm, the strength was lower than that of the ground specimen. The maximum strength reductions were more than 30% for HP-SiC and more than 10% for RB-SiC of those of the original ground specimens, respectively. In addition, when the removed surface layers were more than about 10 μm, the strength of each SiC ceramics recovered, and each showed a constant value regardless of the thickness. The strength seemed to have a similar value to the inherent strength of each SiC ceramics, and it was considered to be independent of the surface damage which was induced during grinding. In order to explain these reduction in strength, a simple model for the surface damage caused by grinding was proposed by considering internal cracks near the surface. The relationships between the thickness of removed layer and the theoretical specimen strength based on the model showed the same tendency as the experimental results. [*Received October 21, 1985*]