Observation of Stress Induced Phase Transformation in Y_2O_3-PSZ by Raman Microprobe

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The distribution of monoclinic phase in Y_2O_3-PSZ, induced by the stress field around Vicker's indents, was examined by using a new system of Raman microprobe. This system is equipped with a step scanning X-Y stage and a multichannel detector and was used to obtain the monoclinic distribution, i. e. the 2-dimensional map of a monoclinic fraction. The results obtained for the PSZ's with 2 and 3 mol % Y_2O_3, 2Y-PSZ and 3Y-PSZ, are described as follows : (1) The monoclinic fraction at the center of indents, where large plastic deformation has occurred, is smaller than that around the edges of each indent. (2) The size of the transformed zone and the monoclinic fraction of 2Y-PSZ around indents were found to be greater than those of 3Y-PSZ. (3) The size of the transformed zone and the monoclinic fraction reach a maximum respectively around 200°C, at which thermal degradation occurs greatly.
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Characterization of Microstructure of Al_2O_3-ZrO_2 Composite by Raman Spectroscopy

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Partially stabilized zirconia is a desirable material as high toughness ceramics. On the other hand, Al_2O_3-ZrO_2 composite is also a desirable material for engineering ceramics because of chemical stability, high hardness, high wear resistance and high toughness. Some properties of Al_2O_3-ZrO_2 composites such as critical grain size for tetragonal ZrO_2 and mechanical behabior have been reported, but studies on the transformation behavior are scarce.

In the present research, the microstructure and transformation behavior of zirconia in Al_2O_3-ZrO_2 composites were studied. Specimens containing 5 to 15 vol % ZrO_2 were hot-pressed and analyzed mainly by laser Raman spectroscopy and microstructure was observed by SEM.

The transformation of zirconia in Vickers-indented areas was more pronounced near the edge (stress concentrated area) than the center area. On the fracture surface after the bending test, the transformation proceeded in the tensile stress area, i. e., the fracture origin. Therefore, it was thought that the stress-induced transformation is closely related to tensile stress.
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A Study of High Temperature Behavior and Microstructures of Al_2O_3-ZrO_2 Composites with a 3MV High Voltage Electron Microscope

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Al_2O_3-ZrO_2 composites have been extensively investigated with a 3 MV electron microscope on the effect of oxide additives such as ZrO_2, MgO and Y_2O_3 on microstructures and determination of the most suitable heat treatment conditions to increase the toughness. The results obtained are : (1) MgO and ZrO_2 additive powders generally suppress the growth of Al_2O_3 grains, (2) voids are almost completely eliminated by ZrO_2 addition due to not only enhancement of sintering around very fine ZrO_2 powders but also good affinity between Al_2O_3 and ZrO_2, (3) grain sizes of both Al_2O_3 and ZrO_2 in Al_2O_3-ZrO_2 composites are not affected with a small amount of MgO, (4) ZrO_2 in Al_2O_3 + ZrO_2 composites is monoclinic at room

temperature, but ZrO_2 in Al_2O_3+ YTZ(Yttria Toughened Zirconia) composites is tetragonal in general, (5) grain sizes of both Al_2O_3 and ZrO_2 in Al_2O_3+ YTZ composites are not sensitive to the addition of a small amount of MgO. Furthermore, in the present experiment, using a very-high temperature stage, annealing and mechanical phenomena of Al_2O_3-ZrO_2 composites have been studied up to 2300 K by in situ experiments with a 3 MV electron microscope. [Received February 13, 1986]

Strengthening of Alumina

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Relatively large Al_2O_3 disc particles (16 μm, 41 μm) with high aspect ratios (5-20) were incorporated into a fine-grain Al_2O_3 matrix ($\sim$1 μm) in order to improve the mechanical properties of sintered Al_2O_3. The flexural strength depends on the disc size and the microstructure of composites. For a composite containing 5 vol% 16 μm Al_2O_3 disc particles, the maximum flexural strength was 604 MPa, 28.5% larger than that without disc particles. [Received February 15, 1986]

Microstructures and Mechanical Properties of TiO_2-Added Alumina Ceramics

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The microstructure and bending strength of alumina ceramics containing 0-16 wt% TiO_2 fired from 1400° to 1700°C were investigated. The addition of TiO_2 markedly promoted the sintering of alumina at comparatively low temperatures in air. The addition of TiO_2 within the solid solubility limit of TiO_2 (0.27 wt%) also promoted the grain growth of α-Al_2O_3 at 1600°-1700°C. An excess amount of TiO_2 over the solid solubility limit reacted with alumina to form aluminum titanate above 1500°C and dispersed in alumina ceramics. Al_2TiO_5 as a second phase prevented the grain growth of α-Al_2O_3, and the grain size of α-Al_2O_3 decreased with increasing amount of TiO_2. The bending strength of specimens fired at lower temperatures increased with increasing amount of TiO_2, i.e., with an increase in fired density. In the specimens fired above 1500°C, the bending strength was lowest for 0.2 wt% TiO_2 addition and increased with further increase in the amount of TiO_2, i.e., with a decrease in grain size of α-Al_2O_3, but the specimens containing a large amount of Al_2TiO_5 had relatively low bending strengths. In the specimens containing Al_2TiO_5, some strain appeared in both α-Al_2O_3 and Al_2TiO_5 grains due to the difference in their thermal expansion coefficients. [Received February 18, 1986]

Microstructure and Mechanical Properties of Al_2O_3-SiC Composites

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The effects of SiC dispersions with average particle sizes of 2 and 8 μm on the microstructure and mechanical properties were investigated for Al_2O_3-SiC composites, which were fabricated at 1500° to 1800°C for 1 h under the applied pressure 27 MN/m^2. The sintering temperature increased with increasing the SiC content. However, the grain growth of Al_2O_3 was remarkably inhibited by incorporating SiC particles, especially those of 2 μm. The Vickers hardness of composites increased with increasing the SiC content. The maximum toughness and strength, 4.5 MN/m$^{3/2}$ and 490 MN/m^2, were observed for the composite containing 10 mol% 2μm SiC prepared at 1600°C, approximately 40% higher than those with Al_2O_3 only. The increases may be attributed to the increase in toughness by crack deflection and/or microcracking caused by the SiC dispersions. [Received February 20, 1986]