

Compressive Deformation Properties and Microstructures in the Superplastic Y-TZP

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The superplastic deformation properties of 3 mol % Y_2O_3 -stabilized tetragonal ZrO_2 polycrystals (Y-TZP) were studied by uniaxial compression tests in air at temperatures up to 1500°C with strain rates ranging from 10^{-3} to 10^{-4} s $^{-1}$. The effect of microstructure on the superplasticity was also examined. Fine-grained Y-TZP with an average grain size of 0.3-0.4 μ m was deformed to the true strain of more than -1.5. The macroscopic strain rate ($\dot{\epsilon}$) in superplasticity was expressed phenomenologically by the following equation,

$$\dot{\epsilon} = 2 \times 10^{-4} \exp(-380000/RT) \sigma^{n'} / d^{m'}$$

where T , σ , and d are temperature, stress, and grain size, respectively, and R is the gas constant. Although the microstructure of the deformed specimen showed slight grain growth and slight anisotropic deformation of each grain, the large strain was mainly caused by the grain boundary sliding. The cavitation was not observed in the compressed specimens. ZrO_2 particles maintained tetragonal or cubic phase after the superplastic deformation. The deformation properties and the observed microstructure in the superplasticity of Y-TZP were explained by the Gifkins's model.

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Tetragonal Phase in ZrO_2 - Y_2O_3 Ceramic System

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The phase stability of the cubic and tetragonal phase in ZrO_2 -2-6 mol% Y_2O_3 is studied by X-ray diffraction method and transmission electron microscopy. Two kinds of tetragonal phase, t and t' , and a cubic (t'') phase, are identified consistently. The t -phase is the equilibrium tetragonal phase, which transforms martensitically to the monoclinic phase on further cooling. The t' -phase has a thin plate or lamellar structure, and is formed in the decomposed structure of the cubic (t'') phase. The high resolution electron microscopy reveals that the fine domains (t'' -phase) due to displacement of oxygen atoms appear dispersedly in the initial stage of decomposition, resulting in the tweed contrast.

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Effects of the Grain Boundary and Its Movement on the Oxygen Self-Diffusion in CeO_2 - ZrO_2 Solid Solutions

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The effects of grain boundaries and their movement on the self-diffusion of oxygen ions were studied in polycrystalline solid solutions of fluorite-type 90 mol% CeO_2 -10 mol% ZrO_2 and tetragonal 14 mol% CeO_2 -86 mol% ZrO_2 . Oxygen self-diffusion coefficients were determined using a gas-solid isotope exchange technique and measuring the time dependence of the ^{18}O concentration in the gas phase. The oxygen self-diffusion coefficients were determined at 1570 and 1670 K.

The oxygen self-diffusion was not enhanced by the presence of grain boundaries. However, when rapid movement of grain boundaries due to rapid grain growth occurred, the oxygen self-diffusion was enhanced. The cause of this was interpreted as being due to the creation of a fast diffusion layer in the vicinity of the grain boundaries. The fast diffusion layer was considered to be effective in enhancement of the diffusion not only of the oxygen ions but also of the cations in the oxides.

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