Preparation of Zirconia Ceramics with Straight and Uniform-Sized Channels

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直細孔をもつジルコニアセラミックスの製造

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Firing of zirconia (Y_2O_3 : 3 mol%) powder-carbon fiber compact in air at 1500° - $1600^{\circ}C$ gave a zirconia ceramics with straight channels of uniform diameter.

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1. Introduction

In ceramic filters with a pore size in the micrometer range, channels or capillaries consist of a zigzag and three-dimensional network of intergranular pores. The present authors reported that the firing of an alumina powder-carbon fiber compact in air at 1500° - $1600^{\circ}C$ gave an alumina ceramics with straight channels of uniform diameter and that the diameter could be controlled by the size of carbon fiber¹⁾. In the present paper, we applied this method to the preparation of zirconia ceramics with straight channels.

2. Experimental

The starting oxide was 3 mol% Y_2O_3 - ZrO_2 (3 Y-PSZ) from Toyo Soda Manuf. Co., Ltd. The average particle size was $0.06 \mu m$ (Fig. 1). The carbon fiber was Toreca 300-99 B from Toray Industries, Inc. with the diameter of $5 \mu m$. The fiber was cut into 1-2 mm long filaments. The filaments (7.4 vol%) were mixed with 3 Y-PSZ powders. After addition of ethanol, ultrasonic agitation was used to disperse the carbon filaments. After evaporation of the ethanol to the degree at which the mixture paste had a suitable hardness for extrusion, the paste was formed into noodles of 1.5 mm diameter with an injector in order to align the carbon filaments. The noodles were cut to about 25 mm in length. Several pieces of them were stacked in parallel in a box and,

with addition of a small amount of ethanol, compacted into a specimen of $4 \times 3 \times 26$ mm. After drying, the specimen was isostatically pressed mainly at 3.0 t/cm². 3 Y-PSZ compacts without carbon filaments were also prepared by the same procedure. The firing was done on the 3 Y-PSZ powder bed in an alumina boat in air at 1400° - $1600^{\circ}C$. In order to estimate the density of the 3 Y-PSZ matrix, 3 Y-PSZ compacts without carbon filaments were fired at the same time. The density of the sintered material was measured by a water immersion method.

Fig. 1. 3 mol% Y_2O_3 - ZrO_2 particles.
Marker : $0.2 \mu m$

3. Results

Carbon filaments (7.4 vol%)-3Y-PSZ and carbon filament-free 3Y-PSZ were fired at 1400°-1600°C for 2 h in air. The relative density is shown in Fig. 2. The fracture surfaces are shown in Fig. 3. As can be seen, the present method gives ceramics with straight channels with a uniform diameter. The size of the channels, 5.0-6.5 μm , is close to that of the original carbon filaments. Since both PSZ's have a similar microstructure, the density of the matrix in the carbon filament-PSZ is considered to be close to that of carbon filament-free PSZ.

The effect of firing time on the relative density was small after 1 h at 1500°C. When carbon filament-free PSZ was heated up to 1500°C at ca. 8°C/min, the relative density reached 98% during

Fig. 2. Relative density of sintered body of carbon filament-free PSZ and firing temperature. Firing time = 2 h.

CIP pressure (t/cm^2) :

○; no CIPed, △; 1.5, □; 3.0

Fig. 3. Fracture surface of sintered bodies. Samples were CIPed at 3.0 t/cm^2 and fired for 2 h in air.

Sintering temperature :

A; 1400°C, B; 1500°C, C; 1600°C

Sample and marker

Top; Carbon filament-PSZ. Marker: 10 μm

Middle; Carbon filament-PSZ. Marker: 1 μm

Bottom; Carbon filament-free PSZ. Marker: 1 μm

the heating and increased to 99% by additional 1 or 2 h heating at 1500°C.

Mochida for providing the carbon fiber Toreca.

Reference

- 1) A. Kato and H. Mizumoto, *Ceramics International*, 12 (2) (1986).

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