

Sintering and Electrical Properties of Low-Temperature Synthesized Gd-Doped Ceria from Polymerized Precursor Solutions

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INTRODUCTION

Among many solution processes for ceramic powders, polymeric precursor synthesis, a liquid-mix process, originated from Pechini technique has been developed as a promising method with inexpensive starting materials and processing supplies and simple operating procedures for making fine mixed-cation oxide powders with exactly controlled composition. Using this technique, the nano-sized crystalline $Ce_{0.9}Gd_{0.1}O_{1.95}$ (CGO) powder has been obtained directly from the solid intermediates derived from the polymerized precursor solution at the temperature as low as 130°C [1]. In this work, the sinterability of the low-temperature derived CGO powder and the electrical properties of the sintered bodies are investigated.

EXPERIMENTAL

The preparation, polymerization and characterization of the polymer precursor solutions with final composition of $Ce_{0.9}Gd_{0.1}O_{1.95}$ was described in detail elsewhere [1]. After drying at 130°C, solid intermediates were obtained from the polymerized solution. The reactions, crystallization and morphology of the derived solid intermediates were analyzed by TG-DTA, XRD and SEM. The specific surface areas of the derived powders at elevated temperatures were measured by BET method. The sinterability of the low-temperature derived CGO powder was examined at 1100-1500 °C. The temperature dependence of the electrical conductivity of the CGO sintered bodies was obtained in air by two-probe ac impedance spectroscopy using platinum electrodes.

RESULTS AND DISCUSSION

The direct formation of the crystalline CGO powder from the solid intermediate derived at 130°C from the polymerized solution is evidenced again in this work, as shown in XRD patterns of Fig. 1. This low-temperature obtained CGO powder shows a maximum specific surface area of 103 m²/g after calcining at 400°C, which is much higher than that of the powder derived from the solution without polymerization. Fig. 2 shows the relative sintering densities and the shrinkages of the CGO compacts as a function of the firing temperatures. It is indicated that the CGO sintered bodies reached a sintering density of 92-99% in the temperature range of 1200-1400°C. Fig. 3 shows the temperature dependence of the bulk conductivities of two CGO electrolytes and that of a comparing YSZ electrolyte. It is indicated that the CGO electrolytes sintered at 1200 and 1400°C exhibit almost the same ionic conductivities, which are obviously higher than that of the YSZ electrolyte below 700°C.

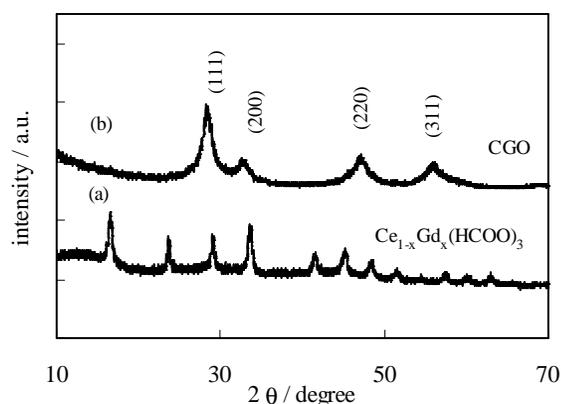


Fig. 1 XRD patterns of the solid intermediates derived from (a) polymerized solution and (b) as prepared precursor solution at 130°C in air.

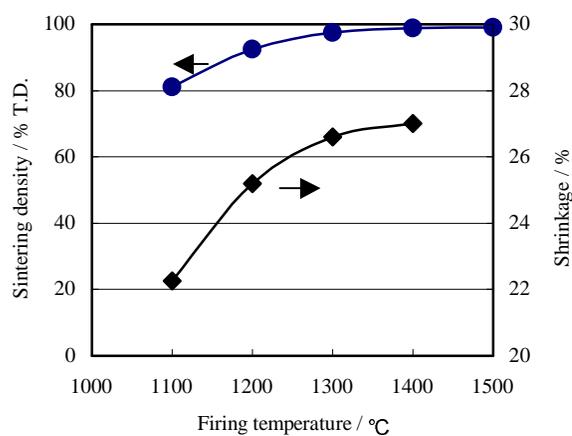


Fig. 2 Relative sintering densities and shrinkages of the low-temperature synthesized CGO as a function of firing temperature.

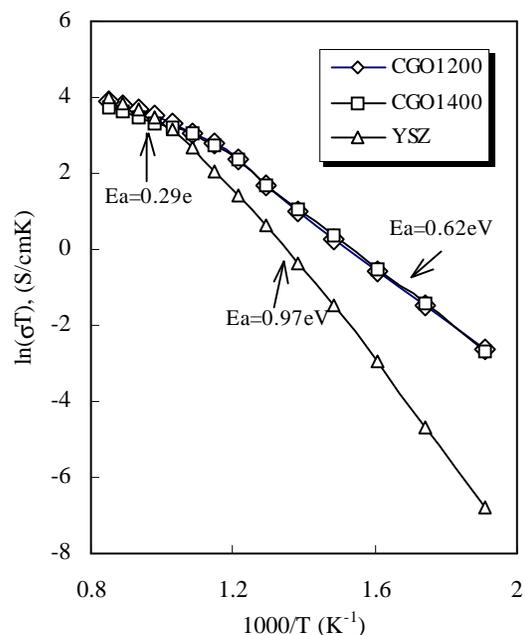


Fig. 3 Temperature dependences of the bulk conductivities of the low-temperature derived CGO sintered at 1200 and 1400°C for 6 h in air, compared with that of a YSZ electrolyte, the data being derived from the impedance spectra tested in air.