

Single cell performance of solid oxide fuel cell using perovskite oxide of  $(\text{Ba}_{0.3}\text{Sr}_{0.2}\text{La}_{0.5})\text{InO}_{2.75}$

Katsuyoshi Kakinuma<sup>a</sup>, Hiroshi Yamamura<sup>a</sup>, and Tooru Atake<sup>b</sup>

<sup>a</sup>Department of Applied Chemistry, Kanagawa University, Rokkakubashi 3-27-1 Kanagawa-ku, Yokohama, 221-8686, Japan.

<sup>b</sup>Materials and Structures Laboratory, Tokyo Institute of Technology, Nagatsuta-cho 4259, Midori-ku, Yokohama, 226-8503, Japan.

The brownmillerite-type oxide of  $\text{Ba}_2\text{In}_2\text{O}_5$  is one of the important materials for oxide-ion conductor. The system has disordered oxygen vacancy and shows the high oxide-ion conductivity above 930°C. Under the temperature, the vacancy is in the ordered state and the ion conductivity decreased abruptly. With doping the rare-earth element of La, the discontinuous jump of conductivity vanished and the orthorhombic symmetry changed to cubic one. Moreover, the oxide-ion conductivity increased in wide range of temperature and reached 0.12(S/cm) at 800°C. The conductivity exceeded that of yttria-stabilized zirconia.[1,2,3]

In order to elucidate the reason why the oxide-ion conductivity increased in the system, the oxygen arrangement, crystal symmetry, and unit cell free volume were investigated. The oxygen vacancy was found to be disordered state with doping La element from the result of transmittance electron microscopy. It is supposed that the amount of mobile oxide-ion would increase. The oxide-ion conductivity of the system was shown as a function of unit cell free volume in Fig. 1. The oxide-ion conductivity increased with free volume up to  $24.3 \text{ \AA}^3$  and then decreased. The former result would be connected with the enhancement of oxide-ion mobility, and the latter result would be related with the change of crystal symmetry from the results of XRD pattern and Raman spectra.

From these systematic studies,  $(\text{Ba}_{0.3}\text{Sr}_{0.2}\text{La}_{0.5})\text{InO}_{2.75}$  was found to be one of the high oxide-ion conductor. So, a single cell of SOFC, in which the oxide was used as an electrolyte, was constructed.[4] The open circuit voltage (O.C.V.) and power density was investigated in the operating temperature of 800°C. The moistened 10% hydrogen balanced with argon gas was supplied at a rate of 100 ml/min as the fuel gas. Ni was selected as an anode material.  $(\text{La}_{0.6}\text{Sr}_{0.4})\text{MnO}_3$  and doped system was used as a cathode material. The power density and terminal voltage were shown in Fig. 2. The open circuit voltage (O.C.V.) of each cell reached 0.90 (V), which was equal to the theoretical O.C.V. The power density increased with doping Fe in  $(\text{La}_{0.6}\text{Sr}_{0.4})\text{MnO}_3$ , which was used as a cathode. It is supposed that the oxide-ion conductivity in cathode material would increase with Fe doping.

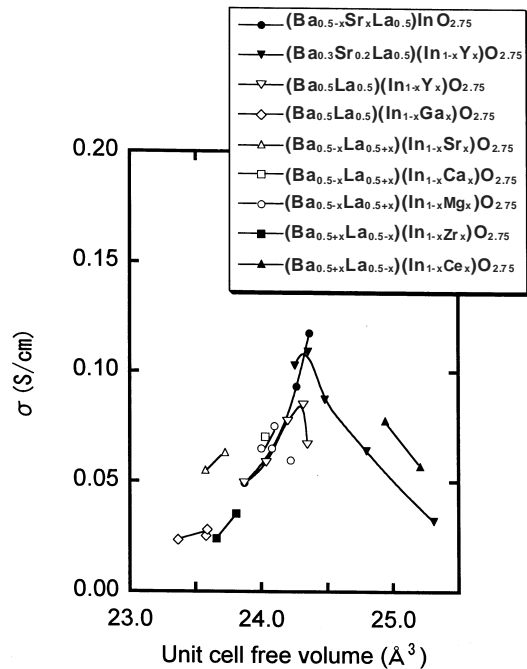


Fig. 1 Oxide-ion conductivity as a function of unit cell free volume.

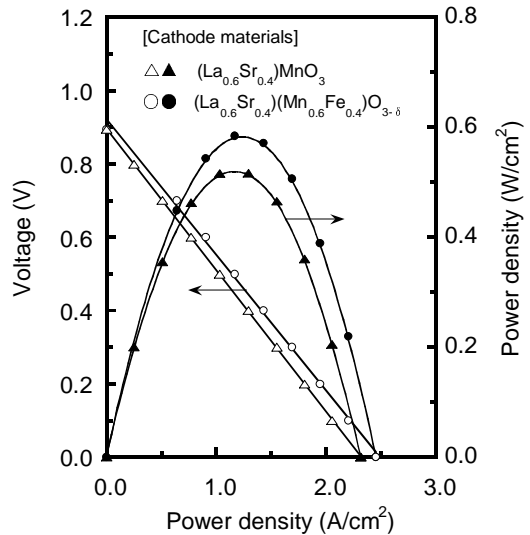


Fig. 2 Single cell performance of SOFC using  $(\text{Ba}_{0.3}\text{Sr}_{0.2}\text{La}_{0.5})\text{InO}_{2.75}$  as an electrolyte. Anode material was Ni.

- [1] K.Kakinuma, H.Yamamura, H.Haneda and T. Atake *Solid State Ionics*, 2001, 140, 301.
- [2] K.Kakinuma, H.Yamamura, H.Haneda and T. Atake, *Solid State Ionics*, 2002, 154-155, 571.
- [3] K.Kakinuma, N.Takahashi, H.Yamamura, and T. Atake, *Solid State Ionics*, 2004, 168, 69.
- [4] K.Kakinuma, T.Arisaka, H.Yamamura, and T. Atake *Solid State Ionics*, in printing.