Correlation of crystallinity of SOFC electrolyte and output power

Takehito Mukai, Shigeki Tsukui, Motoaki Adachi, Kenichi Yoshida*, Hiroki Ishibashi, Ryo Hatayama, Yoshiharu Kakehi, Kazuo Satou,** Tadaoki Kusaka****
Osaka Prefecture University
1-1, Gakuen-chyo, Sakai, Osaka, 599-8531, Japan
Ph/Fax +81-72-254-9816
*** Tokyo Metropolitan College of Industrial Technology, 8-17-1, Minamisenjyu, Arakawa-Ku, Tokyo 116-0003, Japan**
**** Technology Research Institute of Osaka Prefecture, 2-7-1, Ayumino, Izumi-si, Osaka 594-1157, Japan**
E-mail: tmukai@chemeng.osakafu-u.ac.jp

1.Introduction

SOFCs are now operating at high temperature (700-800°C), which leads to degradation of SOFC performance. So it is required to operate at intermediate temperature (500~700°C) with high performance.

In the previous work, the YSZ / GDC bilayer electrolyte cells were successfully fabricated by single processing of pulsed laser deposition (PLD) method. This unit cell showed better performance of 400 mW/cm^2 at 600°C*[1].

In this study, for fabricating the high performance YSZ/GDC bilayer cells more quickly by PLD methods, a laser fluence, one of the PLD parameters, is considered. Controlling the laser fluences affects n ot only the deposition rate but also crystallinity of thin films. So, researching the correlation of the crystallinity of thin film and SOFC output power is important.

YSZ deposition rate was the lowest compared to GDC and GSCO, so YSZ is studied in this work.

2.Experimental

YSZ ($(ZrO_2)_{0.92}(Y_2O_3)_{0.08}$) thin films were deposited on Si (100) substrate at difference laser fluence by PLD methods. Crystallinity of thin films were researched by X-ray diffraction (XRD).

To investigate the correlation of the crystallinity of YSZ and SOFC output power, NiO-YSZ (Ni:YSZ＝60:40 Wt%, 500 μm thick) anode supported cells with YSZ and GDC ($(GdO_2)_{0.9}(Y_2O_3)_{0.05}$) bilayer electrolytes, GSCO ($Gd_{0.5}Sr_{0.5}CoO_3$) cathode were prepared by PLD methods. YSZ is fabricated at difference laser fluences. Repetition frequency was 20 Hz.

3.Results

(a) Fabrication of YSZ thin films on the Si (100) substrate at the difference laser fluences

Fig. 1 shows the YSZ thickness and deposition rate as a function of laser fluences. From this result, as increase the laser fluences (6.5 ~ 10.9 kJ/m^2), the deposition rate also increase, but when higher than 10.9 kJ/m^2, deposition rate had the steady value, 5 nm/min.

XRD patterns of YSZ thin film deposited at difference laser fluences (6.5 ~ 18.5 kJ/m^2) are shown in Fig.2.As laser fluences becomes lower (6.5 ~ 8.6 kJ/m^2), good crystalline structure is prepared. It is realized that YSZ selected the (200) direction as crystalline growth orientation at low fluences. While, as fluences becomes larger (10.9 ~ 18.5 kJ/m^2), poor crystalline structures were prepared.

(b) Fabrication of YSZ / GDC bilayer cells, YSZ is prepared at the difference fluences.

NiO-YSZ anode supported cells with YSZ and GDC bilayer cells were prepared by PLD methods. Then, YSZ was fabricated at 6.5, 10.9 kJ/m^2.Power generation characteristics are shown in Fig. 3.Interestingly, maximum power density of both cell were about 400 mW/cm^2 at 600 ºC. From this result, high performance cells is successfully fabricated nevertheless YSZ is deposited at high laser fluence, 10.9 kJ/m^2.

Table 1 Relationship between laser fluences and thickness (Deposition time : 40 min)

Sample Number	1	2	3	4	5	6	7
Laser fluence[kJ/m^2]	18.5	15.9	10.9	8.6	7.0	6.8	6.5
YSZ thickness [μm]	2.18	2.17	2.17	1.85	1.24	0.91	0.70

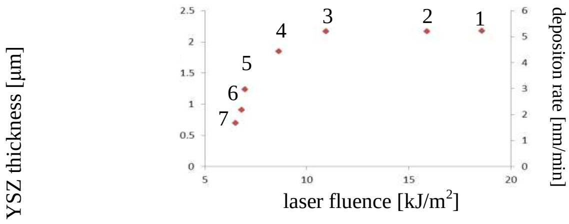

Fig. 1 YSZ thickness and deposition rate as a function of laser fluences..

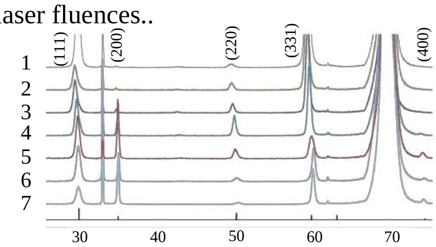

Fig. 2 XRD patterns of YSZ thin film deposited at difference laser fluences on the Si substrate.

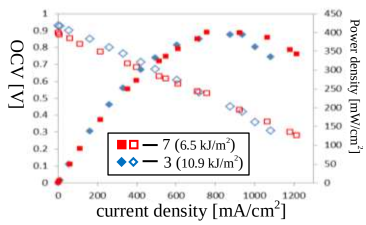

Fig. 3 power generation characteristics of YSZ/GDC bilayer cells , YSZ is deposited at 6.5, 10.9 kJ/m^2.

*1 221st ECS Meeting