FABRICATION OF ANODE SUPPORTED ELECTROLYTE WITH CeScSZ ELECTROLYTE AND NiO-CeScSZ ANODE BY EPD TECHNIQUES

Katsuhiko Yamaji, Haruo Kishimoto, Yueping Xiong, Teruhisa Horita, Natsuko Sakai and Harumi Yokokawa
Energy Electronics Institute
National Institute of Advanced Industrial Science and Technology(AIST)
AIST Tsukuba Central 5,
Tsukuba, Ibaraki 305-8565, Japan

For some years ahead, electrode supported SOFCs attract a great deal of attention because of the high performance at intermediate temperatures especially below 1073 K. In order to fabricate the electrode supported structure, we select the electrophoretic deposition (EPD) technique to fabricate SOFCs.

Fabrication of an anode supported electrolyte by EPD techniques has been tried in our group for recent years(1). In order to fabricate this structure, we have suggested that a noble anode substrate for EPD with lower cost can be developed with carbon powder and a slight amount of starch. With the noble anode substrate, YSZ thin film was successfully fabricated on the NiO-CeScSZ(a slightly ceria-doped scandia stabilized zirconia, $Zr_{0.89}Sc_{0.1}Ce_{0.01}O_{1.9}$) anode substrate by EPD technique and subsequent co-firing process.

In this presentation, an attempt was made to fabricate CeScSZ thin films on NiO-CeScSZ anode substrates by EPD technique in order to decrease the co-firing temperature and also to increase the electrolyte conductivity. Furthermore, results of fundamental SOFC tests on the fabricated anode supported cells.

The anode substrate was made of NiO (Wako Pure Chemical, 99.9%), CeScSZ (Daiichikigennso, $Zr_{0.89}Sc_{0.1}Ce_{0.01}O_{1.9}$), carbon (Showa Denko, Ultra Fine Graphite), and soluble starch (Kokusan Chemical) powders. The weight ratio of anode materials (NiO:CeScSZ) was 1:1. The powders were mixed and shaped into disks with a diameter of 22 mmϕ. The pellets were pressed with Cold Isostatic Press (CIP) machine, and then electrically conductive EPD substrates were obtained.

The schematic view of EPD equipment is shown in Fig. 1. The counter electrode was made from a stainless steel mesh. EPD bath was prepared via following processes. The CeScSZ powder is added into a solvent of 1-propernol. The amount of powder was 0.005 g / cc. The solvent added the powder was dispersed by ultra sonic vibration for 30 min and was statically kept for an hour. The sediment was removed out of the bath after keeping. After the solvent was dispersed again with a little amount of poly vinyl butyral (PVB) as a binder, the bath was applied for EPD. In the EPD process, the substrate and the counter electrode were symmetrically placed and the distance between them was about 10 mm. The substrate and the counter electrode worked as the negative and positive electrodes, respectively.

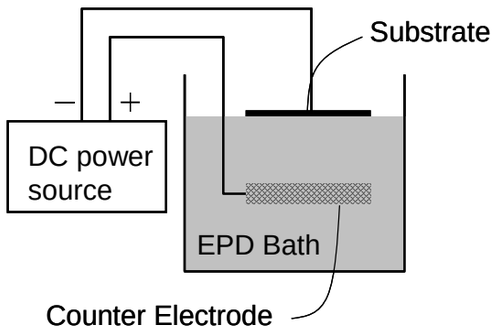

Fig. 1 Schematic View of EPD equipment

During the EPD process in 5 to 15 min, DC voltage around 200V was applied between the electrodes. After EPD process, the EPD substrate with the deposited electrolyte layer was dried up slowly to avoid a formation of cracks in the deposited layer. The dried substrate with deposited electrolyte powder was co-fired at 1473 to 1548 K for 5 h, and then the anode supported thin electrolyte structure of CeScSZ/NiO-CeScSZ was obtained.

From the SEM measurement of these anode supported cells co-fired at various temperatures of 1473 K to 1548 K for 5 h, dense CeScSZ films with thickness of 5 to 10 μm were successfully obtained on porous anode substrates of NiO-CeScSZ.

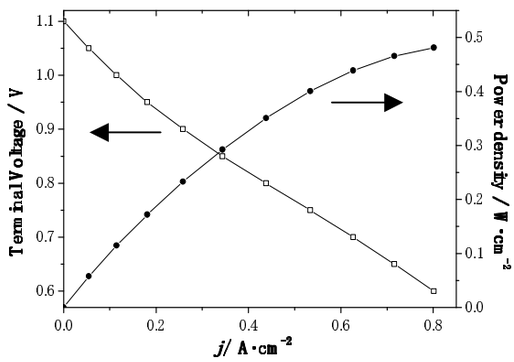

Fig. 2 Power generation test.

Single SOFC tests were carried out for the crack free anode supported electrolytes. Platinum paste or LSM(lanthanum strontium manganite, $(La_{0.75}Sr_{0.25})_{0.95}MnO_{3-\delta}$) was fired onto the electrolyte as the cathode with the area of 10mmϕ. 100 ccm of air and 30 ccm of H_2 with 1.2% H_2O were flown onto the cathode and the anode, respectively. The result of the OCV(open circuit voltage) measurements for samples with no visible cracks on the electrolytes indicate that all anode supported CeScSZ films co-fired at temperatures from 1473 to 1548 K are fully dense. Figure 2 shows the result of the power generation test with LSM cathode at 1073 K. The power density was reached to 480 $mWcm^{-2}$ at the current density of 0.8 Acm^{-2} when the applied potential vs. OCV was -500 mV.

Reference: (1) K. Yamaji *et al.*, Proceedings of the Fifth European Solid Oxide Fuel Cell Forum, July 2002, Joep Huijsmans, Editor, European Fuel Cell Forum, ISBN 3-905592-10-X, pp. 140-147