Preparation of YSZ Thin Film for Electrolyte of SOFCs by Electron Beam PVD

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It has been well known that ohmic loss can be smaller by reducing the thickness of an electrolyte in solid oxide fuel cells (SOFCs)[1-3]. As thin electrolyte should be dense enough to prevent gas crossflow, several methods, such as slurry coating, plasma sraying[4], or electrochemical vapor deposition (EVD)[5], have been tried to prepare doped zirconia electrolytes. On the other hand, electron beam physical vapor deposition (EB-PVD) technique offers several advantages such as high deposition rates, formation of more durable and dense coating layer, precise composition control and use of high melting point oxide. In this study, we have investigated the possibility of applying EB-PVD method for thin and dense electrolyte preparation. The effects of parameters, such as deposition time, substrate temperature, oxygen flow rate, and electron-beam power, on the morphology and microstructure of electrolyte film have been analyzed.

8 mol% yttria doped zirconia (YSZ, Tosho Co.) was compacted to form a disc-shaped ingot. Film-type YSZ was deposited on a porous anode (Ni-YSZ) or cathode ($LaSrCoO_3$, $LaSrMnO_3$) using 10 kW electron beam equipment. We have varied substrate temperature at 873~1073 K and have flowed oxygen to control oxygen partial pressure of the chamber. Dense film of 5 ~ 10 μm in thickness was coated uniformly on the substrates as shown in Fig. 1. The XRD patterns showed that the deposited layers are composed of highly oriented tetragonal phase (Fig. 2). The other electrode was coated on the YSZ layer using a slurry coating method to make a single cell. power density and cathodic overpotential of the single cell has been characterized. Applicability of new EB-PVD technology for the fabrication of SOFC electrolyte has been discussed.

References

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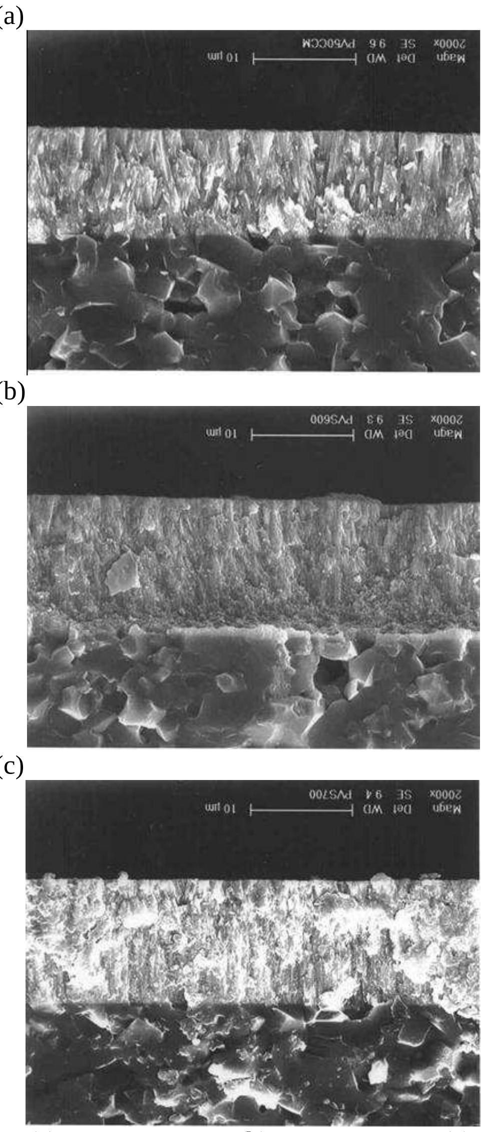
(a)
(b)
(c)



(a) (b) (c)

Fig 1. SEM photographs of YSZ electrolyte film deposited on porous substrate. The substrate temperature during deposition was maintained at (a) 873 K , (b) 973 K, and (c) 1073 K respectively.

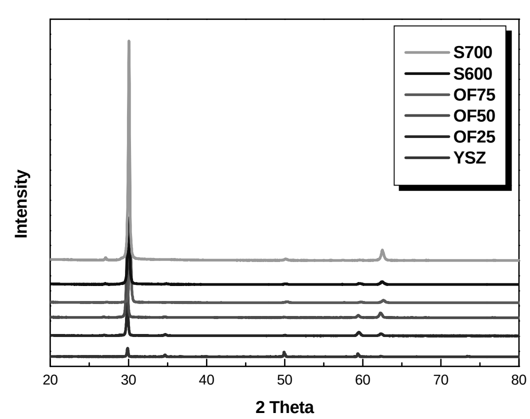


Fig 2. X-ray diffraction patterns of YSZ layers, which have been prepared under various temperature and oxygen flow rate conditions.