

One-step Fabrication of Nano-Structured Solid Oxide Fuel Cells by Electrostatic Spray Deposition

Quanzhi He, Arturo Veiga Lopez,
J. Robert Selman*⁺ and Philip Nash

Dept of Mechanical, Materials and Aerospace Eng.,
Illinois Institute of Technology, Chicago, IL 60616

*Dept of Chemical and Biological Eng., Illinois Institute
of Technology, Chicago, IL 60616

⁺ Corresponding author

This communication reports an effort to develop a one-step fabrication process for a solid oxide fuel cell (SOFC) electrode-electrolyte assembly by means of electrostatic spray deposition (ESD) of ceramic powders. The ESD of a dense YSZ layer from slurries of YSZ powder was reported in an earlier publication [1].

The work reported here was focused on producing a dense layer of yttria stabilized zirconia (YSZ) of $< 10 \mu\text{m}$ thickness. Figure 1 shows a schematic of the ESD apparatus, which provides complete control of seven adjustable parameters. The parameters controlling the spray modes, the as-deposited (green) layer microstructure, and the sintering to complete densification were identified by systematic variation.

It was found that the microstructure (porous or dense) of as-deposited film was dominated by the type of suspension solution and substrate temperature. The important parameters controlling the uniformity of the layer were identified as applied ESD voltage and the distance nozzle-substrate.

The concentration range of the YSZ suspension in this study (1-2 wt%) was higher than that used in earlier studies, in order to increase the deposit growth rate as much as possible.

Figure 2a shows an as-deposited layer with a microstructure that allows complete densification by subsequent sintering at temperature well below those used in similar synthesis of SOFC assemblies [2]. Figure 2b shows the result of sintering at 1300°C at 10hrs. The resulting layer is pore-free, at a thickness of $0.75 \mu\text{m}$. Similar density can be achieved at sintering temperatures down to 1250°C .

Further study concerning the sintering process shows the possibility of sintering a complete (3-part) SOFC by adjusting the microstructure of as-deposited thin films and powder size.

REFERENCES

1. Nomura, H., S.Parekh, J.R. Selman, and S.Al-Hallaj, *J. Appl.Electrochemistry* vol.35 (2005) 61-67.
2. Park, I., J. Ahn, J.Im and D. Shin, *Ceramics International* vol. 38 (2012) S481-S484.

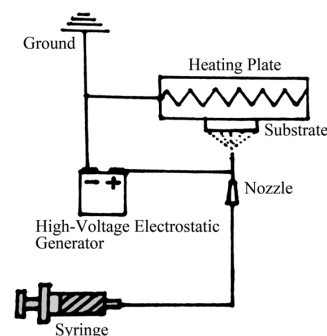


Figure 1. Schematic of Electrostatic Spray Deposition apparatus.

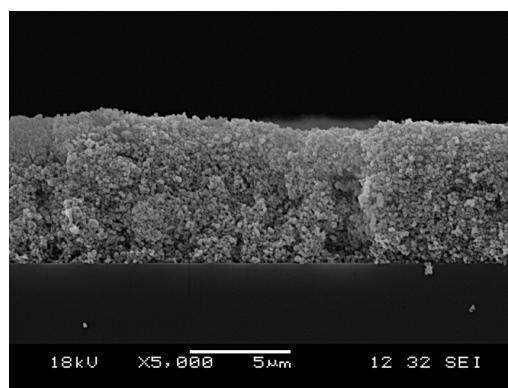


Figure 2a. YSZ deposit by ESD as green layer

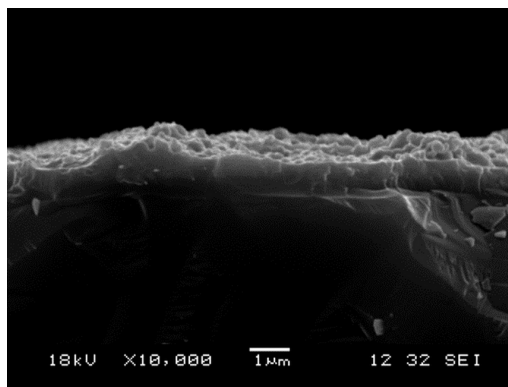


Figure 2b. YSZ deposit by ESD after sintering at 1300°C for 10 hrs

