Development of bolt-microtubular solid oxide fuel cells

Sezer Onbilgin [1, 2], Tolga Altan [1, 2], Cigdem Timurkutluk [1, 3] and Bora Timurkutluk [1,2]

[1]Nigde Omer Halisdemir University, Prof. Dr. T. Nejat Veziroglu Clean Energy Research Center, 51240, Nigde, Türkiye

[2]Nigde Omer Halisdemir University, Mechanical Engineering Department, 51240, Nigde, Türkiye

[3]Nigde Omer Halisdemir University, Department of Energy Science and Technologies, 51240, Nigde, Türkiye

In this study, the effect of anode support thickness on the formability and performance of bolt-microtubular anode supports, for which the geometry has been recently introduced in the literature [1], are investigated. For this purpose, a tape casting slurry of NiO-YSZ (66-34 wt. %) anode support layer was prepared by using proper amounts of dispersant (fish oil), solvent (a mixture of methyl ethyl ketone and ethanol), binder (polyvinyl butyral) and plasticizer (polyethylene glycol). After ball milling and magnetic stirring processes, the slurry was tape cast with 300 µm doctor blade gap. The tape width was adjusted to 10 cm. Following drying under ambient conditions, ~10 cm, ~15 cm and ~25 cm long anode support tapes were cut. These tapes were then wrapped on a threaded rod of M5 class having 5 mm major diameter. After the lamination under 70 MPa pressure for 4 min at 60 °C with an isostatic pressing device, the threaded rod was removed. The bolt-microtubular anode supports were cut by a laser cutting device and fired at 1100 °C for 1h. Next, NiO-YSZ (50-50 wt. %) anode functional layer was dip coated followed by sintering at 1150 °C for 2h. Similarly, YSZ electrolyte, LSM-YSZ (wt. %: 40-60) cathode functional layer and LSM-YSZ (wt. %: 90-10) cathode current collections are dip coated in the given order. The electrolyte layer was sintering at 1400 °C for 4h, while the sintering of both cathode layers were achieved at 1000 °C for 2h. Besides the bolt-microtubular cells (Bs), conventional microtubular anode supports were prepared by using a rod having 5 mm diameter and microtubular cells (Ms) were built on these supports similarly for comparison. The photos of the bolt-microtubular and micortubular cell prepared with ~15 cm long anode support tape are shown in Figure 1.

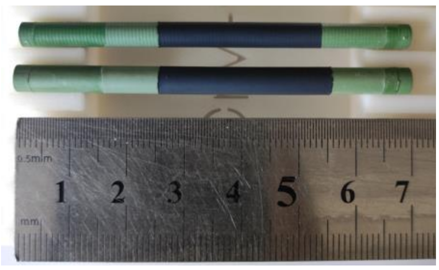

Figure 1. Photo of bolt-microtubular (top) and microtubular cell (bottom)

Physical properties of the cells and anode supports were determined by a stereoscopic microscope (Leica EZ4 W, Leica Microsystems, Germany), while the electrochemical performances of the cells were also measured at 800 °C under 0.3 NL/min hydrogen flow by a fuel cell test station (Arbin Instruments, FCTS, Texas, USA) with external current collection strategy by using a silver wire of 0.5 mm diamater. The structural analyses show that the degree of patterning tends to decrease with increasing the length of anode support tape. The electrochemical performances of bolt-microtubular cells (B1 with ~15 cm and B2 with ~25 cm tape length) and microtubular cells (M1 with ~15 cm and M2 with ~25 cm tape length) are compared in Figure 2. The cells with ~10 cm long anode support tape are broken during the tests due to inadequate support thickness. The results indicate that bolt-microtubular cells overperform conventional ones and the performance improves with the degree of surface patterning due to increased electrochemical reaction zones by enlarging electrolyte-electrode interfaces.

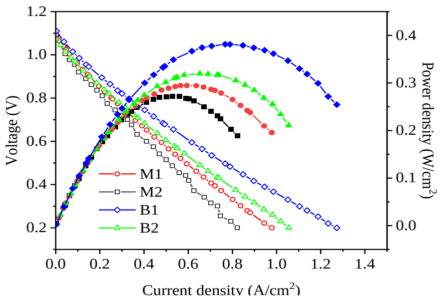

Figure 2. Electrochemical performances of the cells

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References

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Bora Timurkutluk is a professor in Mechanical Engineering Department at Nigde Omer Halisdemir University and the director of Prof. Dr. T. Nejat Veziroglu Clean Energy Research Center and the head of Mechanical Engineering Department..He has over 15 years experiences in hydrogen and fuel cell technologies. His main research interest is solid oxide fuel cells and is specifically doing research on microtubular solid oxide fuel cells, alternative fabrication techniques and microstructural engineering of electrodes besides the studies on design, modeling, fabrication, test and characterization at cell, stack and system levels.

Presentating author: Bora Timurkutluk, e-mail: bora.timurkutluk@ohu.edu.tr tel: +903882252337