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# Electrochemical Performance of Femtosecond Laser Structured Commercial Solid Oxide Fuel Cells Electrolyte

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**Abstract :** Solid oxide fuel cells (SOFC) efficiently convert hydrogen to energy without producing any disturbances or contaminants. The core of the cell is electrolyte. For improving the performance of electrolyte-supported cells, it is desirable to extend the available exchange surface area by micro-structuring of the electrolyte with laser-based micromachining. This study investigated the electrochemical performance of cells micro machined using a femtosecond laser. Commercial ceramic SOFC (Elcogen, AS) with a total thickness of 400 μm was structured by 1030 nm wavelength Yb: KGW fs-laser Pharos (Light Conversion) using 100 kHz repetition frequency and 290 fs pulse length light by scanning with the galvanometer scanner (ScanLab) and focused with a f-Theta telecentric lens (SillOptics). The sample height was positioned using a motorized z-stage. The microstructures were formed using a laser spiral trepanning in Ni/YSZ anode supported membrane at the central part of the ceramic piece of 5.5 mm diameter at active area of the cell. All surface was drilled with 275 μm diameter holes spaced by 275 μm. The machining processes were carried out under ambient conditions. The microstructural effects of the femtosecond laser treatment on the electrolyte surface were investigated prior to the electrochemical characterisation using a scanning electron microscope (SEM) Quanta 200 FEG (FEI). The Novo control Alpha-A was used for electrochemical impedance spectroscopy on a symmetrical cell configuration with an excitation amplitude of 25 mV and a frequency range of 1 MHz to 0.1 Hz. The fuel cell characterization of the cell was examined on open flanges test setup by Fiaxell. Using nickel mesh on the anode side and au mesh on the cathode side, the cell was electrically linked. The cell was placed in a Kittec furnace with a Process IDentifier temperature controller. The wires were connected to a Solartron 1260/1287 frequency analyzer for the impedance and current-voltage characterization. In order to determine the impact of the anode's microstructure on the performance of the commercial cells, the acquired results were compared to cells with unstructured anode. Geometrical studies verified that the depth of the -holes increased linearly according to laser energy and scanning times. On the other hand, it reduced as the scanning speed increased. The electrochemical analysis demonstrates that the open circuit voltage OCV values of the two cells are equal. Further, the modified cell's initial slope reduces to 0.209 from 0.253 of the unmodified cell, revealing that the surface modification considerably decreases energy loss. Plus, the maximum power density for the cell with the microstructure and the reference cell respectively, are 1.45 and 1.16 $Wcm^{-2}$.

**Keywords :** electrochemical performance, electrolyte-supported cells, laser micro-structuring, solid oxide fuel cells
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