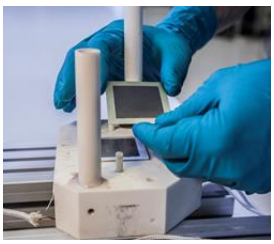
Reversible solid oxide Electrolyzer and Fuel cell for optimized Local Energy miX



WP2 Objectives

WP2 aims to optimize cell microstructure and stack design for reversible Solid Oxide Cell (rSOC) operation. Targeting high fuel utilization (85 %) at high current densities (0.6 A cm^{-2} and -1.2 A cm^{-2}), optimal mechanical strength, diffusion properties and durable electrochemical performance must be obtained.

Cell durability

Optimized cells have been used for single cell durability tests including SOFC, SOEC and load-cycling test periods. Fig. 1 depicts cell voltage curves for test operated at 700°C, 80% FU, 0.6 Acm^{-2} and −1.2 Acm^{-2}, respectively in SOFC and SOEC mode. SOEC operation led to significant degradation while degradation during SOFC was limited.

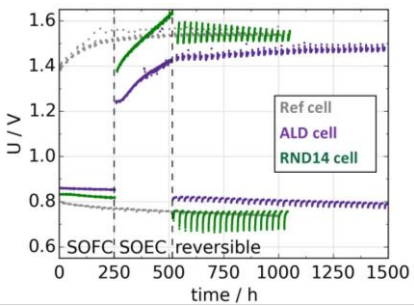


Fig 1. Cell voltage over time for single cell durability test. Load cycling: 8 h SOEC/16 h SOFC.

Cell degradation

Impedance spectra analysis reveals that the majority of the degradation was due to the fuel electrode and an increase of ohmic resistance was observed as well (see fig. 2).

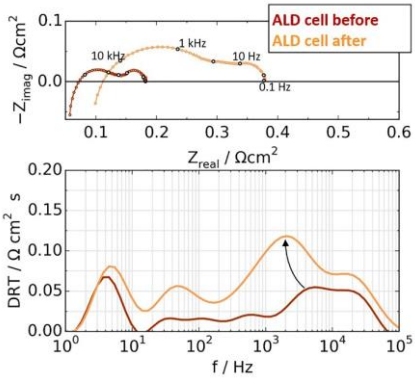


Fig 2. Impedance spectra at 700 °C, OCV, air and H_2/H_2O:5050 before and after durability test.

Initial performance of stacks

Two stacks of five cells were manufactured comprising Ref. and G2 (structure as for Fig. 1 RND14) optimized cells, respectively. Figure 3 depicts initial performances through i-V curves (stack cells average voltage) recorded in SOEC mode at several temperatures. At 750°C, like at 700°C, G2 cells led to a slightly higher performance of the stack, while at 800°C this it was not the case. At 750°C G2 cells reached -1.2 A cm^{-2} at 1.3V and steam conversion of 77%.

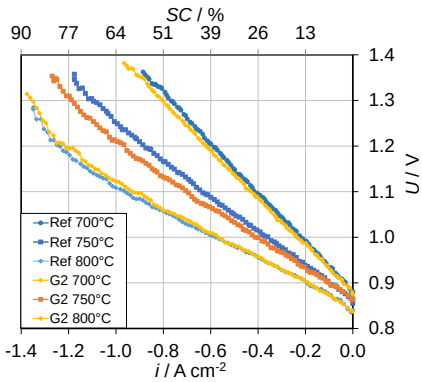


Fig 3. Initial stack performance : SOEC mode Comp H_2O/H_2 90/10 tot. flow 12 NmL min^{-1} cm^{-2} air provided to O_2 electrode.

Stack durability

Each stack was tested by a first period (≈800 h) of SOFC to SOEC load cycling (by ≈100 h steps). They were supplied by 50/50 H_2O/H_2 total flow 12 NmL min^{-1} cm^{-2} on fuel side and air on oxygen side. Stack performances were checked at each change of operating mode through i-V curves (700,750 & 800°C).

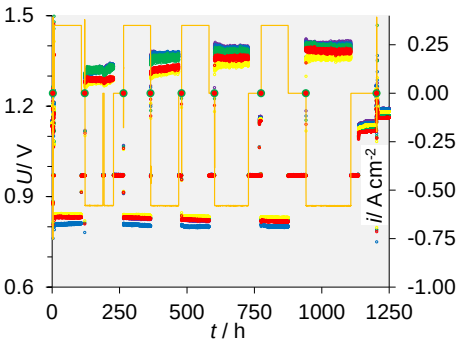


Fig 4. Stack G2 cells 800h load cycling durability test

Durability tests were operated galvanostatic at +0.36/-0.51 Acm^{-2} (ref.Cell) +0.35/-0.58 Acm^{-2} (G2Cell). Then daily load cycling 8 h SOEC/16 h SOFC was operated for 250h.

Despite the higher current during SOEC operation degradation of G2 cell is very similar to Ref cell.

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