

# 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 ( $0.6 \text{ A cm}^{-2}$  and  $-1.2 \text{ A cm}^{-2}$ ), 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  $700^\circ\text{C}$ , 80% FU,  $0.6 \text{ A cm}^{-2}$  and  $-1.2 \text{ A cm}^{-2}$ , respectively in SOFC and SOEC mode. SOEC operation led to significant degradation while degradation during SOFC was limited.

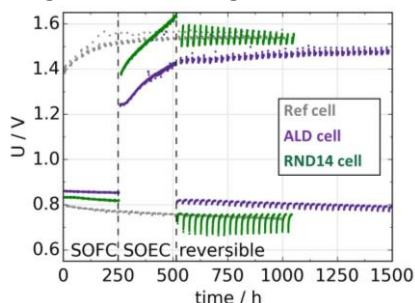


Fig 1. Cell voltage over time for single cell durability test. Load cycling: 8 h SOEC/16 h SOFC.

## 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).

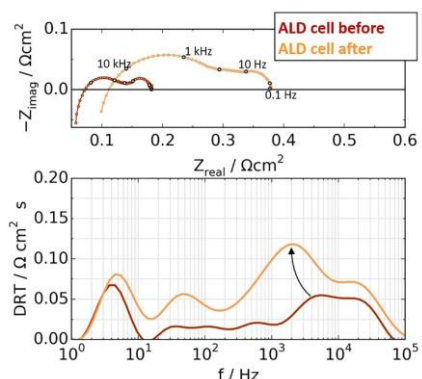
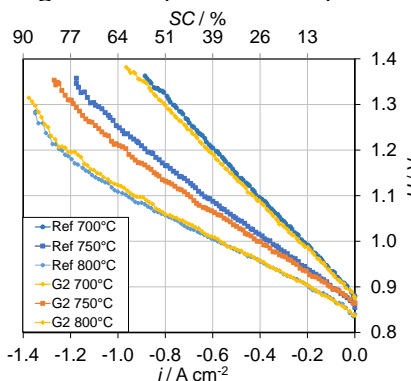


Fig 2. Impedance spectra at  $700^\circ\text{C}$ , OCV, air and  $\text{H}_2/\text{H}_2\text{O}:5050$  before and after durability test.

## Initial performance of stacks

Two stacks of five cells were manufactured comprising Ref. and G2 (same structure as 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 temperature. At  $750^\circ\text{C}$ , like at  $700^\circ\text{C}$  G2 cells lead to a slightly higher performance of the stack, while at  $800^\circ\text{C}$  this it is not the case. At  $750^\circ\text{C}$  G2 cells reached  $-1,2 \text{ A cm}^{-2}$  at 1,3V and steam conversion of 77%.

Fig 3. Initial stack performance : SOEC mode Comp  $\text{H}_2\text{O}/\text{H}_2$  90/10 tot. flow  $12 \text{ NmL min}^{-1} \text{ cm}^{-2}$  air provided to  $\text{O}_2$  electrode.

## Stack durability

Each stack was tested by a first period ( $\approx 800 \text{ h}$ ) of SOFC to SOEC load cycling (by  $\approx 100 \text{ h}$  steps). They were supplied by 50/50  $\text{H}_2\text{O}/\text{H}_2$  total flow  $12 \text{ NmL min}^{-1} \text{ cm}^{-2}$  on fuel side and air on oxygen side. Stack performances were checked at each change of operating mode through i-V curves ( $700, 750$  &  $800^\circ\text{C}$ ).

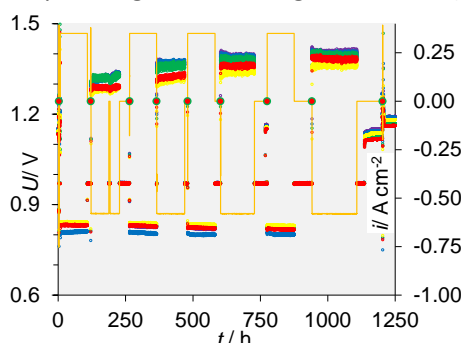


Fig 4. Stack G2 cells 800h load cycling durability test

Durability tests were operated galvanostatic at  $+0.36/-0.51 \text{ A cm}^{-2}$  (ref.Cell)  $+0.35/-0.58 \text{ A cm}^{-2}$  (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.