Highly Efficient, High Temperature, Hydrogen Production by Water Electrolysis

Hi2H2

Publishable executive summary

The project aims to make use of the materials and technological developments on planar SOFC technology and to apply them to develop a planar "Solid Oxide Electrochemical Converter" (SOEC). The objective of the project is to demonstrate a degradation inferior to 1%/1000 hours on a short 5 x 5 cm^2 stack for a period of 2000 hours. Electrode supported cells and metal supported cells are being developed using the SOFC cells as a starting point: The degradation of the SOEC was analysed. Improved metal coatings as well as anode and cathode materials were developed.

During the 2nd year of the Hi2H2 project successful and different electrolysis tests have been performed. The tests have demonstrated that very high performances can be achieved using SOFC cells. The IV-curves showed that the SOECs tested at Risø perform very well compared with similar SOECs reported in literature. So far no SOECs have been reported to have a better initial performance at similar operation conditions. The record-breaking IV-curve was obtained at 950°C for one of the cells. A current density of -3.6 A/cm^2 was obtained at cell voltage of only 1.48 volt (thermoneutral potential) for this IV-curve.

Two different protective layers were selected as candidates for interconnect material compounds for SOEC. The protected interconnects were characterised under different SOEC conditions (high steam content and high oxygen partial pressure).

The passivation/activation phenomenon observed on Risø cells was clearly attributed to the H2 electrode. There was evidence that this is due to the silicate depositing at the interphase between the electrolyte and the hydrogen electrode. Silica was clearly seen at this interphase and at the Ni-YSZ interphase for some of the tested cells. The quantities of silica observed are in certain cases too large to come from impurities in the cell material. They probably come from the glass seal. It should be noted that below ca. 1 A/cm^2 the cells activate again after some time at a slightly passivated state to almost the initial high performance.

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