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Progress in SOC Development at the Forschungszentrum Jülich

Ludger Blum (1), Qingping Fang (1), L.G.J. (Bert) de Haart (1), Jürgen Malzbender (1), Nikolaos Margaritis (2), Norbert H. Menzler (1), Roland Peters (1)

Forschungszentrum Jülich GmbH

(1) Institute of Energy and Climate Research

(2) Central Institute of Engineering, Electronics and Analytics

D-52425 Jülich / Germany

Tel.: +49-2461-616709

Fax: +49-2461-616695

l.blum@fz-juelich.de

Abstract

Forschungszentrum Jülich focused in terms of materials development in recent years on reducing the operating temperature down to 500 °C. First stack test results in this respect are presented.

Furthermore, numerous long-term tests have been carried out in Jülich with operating times of more than 20,000 hours. The stack with the longest time at operating temperature was stopped after 11.5 years, which means 100,000 hours. The analysis results regarding the degradation mechanisms and related post-test results are shown. It is also discussed how harsher operating conditions might affect the degradation.

A 10-layer stack in the window frame design revealed less than 0.02% power loss per cycle, while it was thermally cycled 80 times with a heating gradient of about 2 K/min. It also showed a very stable open circuit voltage. In addition, a 5-layer stack in the novel lightweight cassette design was thermally cycled at a two times-faster heat-up rate. In this case 500 cycles with a comparable result to the window frame stack have been achieved. In the recent years, the realization of an rSOC (reversible Solid Oxide Cell) system with a power output in fuel cell mode of 5 kW was in the focus of systems development. The heart of the system was a window frame stack with 40 layers. This stack has been located in between the air pre-heater and fuel pre-heater in a common thermal insulation (the so-called "Integrated Module"). At a system's fuel utilization of more than 96% the stack delivered 5.3 kW_{DC} in fuel cell mode, which resulted in a DC system efficiency of 62%. At 14.3 kW_{DC} stack input in electrolysis operation 4.75 Nm³h⁻¹ of hydrogen were produced. At that point, the DC efficiency of the system was 70%. Various cycling and part load tests in fuel cell and in electrolysis mode were performed as well as 4,000 h of continuous electrolysis operation. In total, the system has been in operation for more than 8,000 h.

The Authors do not want to publish their full contribution in these proceedings so as to potentially have these published in a journal. For further information, please contact the authors directly.