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Degradation of SOFC stacks: a summary of long-term stack tests

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Abstract

Degradation and lifetime have been always the major aspects to be considered for stationary applications using solid oxide cell (SOC) technology. With continuously improved understanding of degradation mechanisms and optimized materials techniques in the last two decades, the degradation rate of solid oxide fuel cell stacks was decreased significantly from more than 1%/kh to below 0.4%/kh. Long-term stack tests (>3,000 h) of different stack designs, carried out at Forschungszentrum Jülich, have shown that SOFC stacks can be operated stably in a wide range of conditions (i.e., temperatures, current densities, fuel utilization, fuel compositions, thermal cycling, and redox cycling, etc.). The degradation rate is not only dependent on the stack components and operating conditions, but also strongly influenced by the contact situation inside the stack and undesired variations in the testing infrastructures, which are hardly noticeable from outside generally. In this work, a comprehensive analysis and summary of more than 20 long-term SOFC stack tests will be given, focusing on empirical findings on the degradation dependency and the major dominating factors during endurance tests.