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Streszczenie rozprawy doktorskiej pt.:

„Investigation of the stability of oxygen electrode of solid oxide electrolysis cell (SOEC) operated with steam as a sweep gas for simultaneous production of high purity oxygen and hydrogen"

The doctoral dissertation addresses the subject of stability of solid oxide electrochemical cells operating in electrolysis mode (SOEC). The work focuses on verifying the possibility of using water vapor or oxygen streams as a sweep gas of the oxygen electrode side. The work is divided into 6 main chapters.

The introduction discusses the context of the growing interest and role of hydrogen in the global economy. Chapter explain the hydrogen importance in the decarbonization of industry and transport, and how this process is supported by hydrogen strategies implemented in various countries. Here an overview of hydrogen production methods is presented, with particular emphasis on electrolysis as a low-emission alternative.

The dissertation starts with a broad literature overview, which describes the field of high temperature electrolysis cell such as the principle of operation, thermodynamics of the electrolysis process, and material aspects of solid oxide cell technology. This chapter also presents in detail various degradation processes that can occur in high-temperature cells. The degradation issues are addressed separately for each electrode and electrolyte, with particular emphasis on the air electrode, as well as the alternative or special operating conditions.

Chapter 3 presents in detail the analytical and testing techniques used during the experimental campaign. This includes electrochemical measurements such as measurements of current-voltage characteristics (I-V), long-term monitoring of the cell voltage under operating conditions in galvanostatic mode, as well as measurements and analysis of impedance spectroscopy (EIS) results. This chapter also presents the techniques used in post-mortem analysis, where issues related to material changes occurring in the cell electrodes and their microstructure were studied by techniques such as scanning electron microscopy (SEM), elemental analysis (EDS) and X-ray diffraction (XRD).

The experimental work is presented in Chapter 4, where the all the results obtained during SOC cell tests in electrolysis mode are discussed. Experimental campaign covered use of various sweep gases such as steam, nitrogen and oxygen. The results were gathered during a series of short- and long-term measurements of cells. The experimental started with the preparation and adaptation of a research test stand dedicated for testing of 5 cm x 5 cm SOC cells. Next the chapter was divided into 3 subchapters, each of which is devoted to the use of a different sweep gas. In the subchapters the detailed results of electrochemical measurements are discussed, including the evolution of the cell voltage during long-term measurements at a constant current load. At various stages of the cell measurement the impedance spectra were registered and the

rate of degradation of individual cell and its performance change was determined. Additionally to the electrochemical results the analysis of microscopic and material changes were carried out during post-mortem measurements. Each subchapter is summed up with a detailed analysis and interpretation of the obtained results in the form of a discussion and comparison to the available literature.

Chapter 5 presents a comprehensive discussion and comparison of key degradation results obtained during the all experimental studies. The chapter is a general discussion and comparison of the data and an interpretation of results.

The last chapter of the dissertation presents the conclusions, in which the outcome of the studies dedicated for verifying the research hypotheses are discussed. In addition, directions for further approach and area of interest have been proposed that may contribute to the development of the field and an innovative approach to the use of alternative sweep gases

Keywords: SOE, SOC high-temperature electrolysis, hydrogen technologies, degradation

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