High Temperature Co-electrolysis of Steam and CO\textsubscript{2} in an SOC stack: Performance and Durability

High temperature electrolysis based on solid oxide electrolysis cells (SOECs) is a very promising technology for energy storage or production of synthetic fuels. By electrolysis of steam, the SOEC provides an efficient way of producing high purity hydrogen and oxygen [1]. Furthermore, the SOEC units can be used for co-electrolysis of steam and CO\textsubscript{2} to produce synthesis gas (CO+H\textsubscript{2}), which can be further processed to a variety of synthetic fuels such as methane, methanol or DME [2]. Previously we have shown at stack level that Ni/YSZ electrode supported SOEC cells can be operated at 850 oC and -0.5 A/cm\textsuperscript{2} with no long term degradation, as long as the inlet gases to the Ni/YSZ electrode were cleaned [3]. In this work, co-electrolysis of steam and carbon dioxide was studied in a TOFC® 10-cell stack, containing 3 different types of Ni/YSZ electrode supported cells with a footprint of 12X12 cm\textsuperscript{2}. The stack was operated at 800 oC and -0.75 A/cm\textsuperscript{2} with 60% conversion for a period of 1000 hours. One type of the cells showed no long term degradation but actually activation during the entire electrolysis period, while the other two types degraded. The performance and durability of the different cell types is discussed with respect to cell material composition and microstructure. The results of this study show that long term electrolysis is feasible without notable degradation also at lower temperature (800 oC) and higher current density (-0.75 A/cm\textsuperscript{2}).