Long-term stability of $Pr_2NiO_{4+\delta}$ SOEC/SOFC air electrodes under Cr-poisoning conditions

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Solid oxide fuel and electrolyzer cells (SOFCs and SOECs) are highly efficient and low emission energy conversion devices, which could play a vital role in the energy distribution chain in the future. A common degradation mechanism in SOEC and SOFC stacks is poisoning of the air electrode by volatile Cr-species released from metallic components in the stack. In this work, the long-term effects of Cr-poisoning on $Pr_2NiO_{4+\delta}$ (PNO) air electrodes were investigated during SOEC and SOFC operation. Symmetrical button cells were tested at 800°C in dry and humidified O_2/Ar atmospheres with and without current load. Contributions of the electrodes operated in electrolyzer and fuel cell mode were separated using an annular Pt-reference electrode. PNO air electrodes show a stable performance under dry conditions. However, humidification of the test gas with a Cr-source positioned in the vicinity of the cell leads to a selective increase of the area specific resistance (ASR) of the SOFC cathode, while the performance of the SOEC anode remains almost unaffected. The results indicate a strong correlation between Cr deposition and electrode polarization. Post-test analyses using scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDXS) revealed higher levels of Cr on the SOFC cathode than on the SOEC anode, which could be responsible for the measured increase in the ASR. Scanning transmission electron microscopy (STEM) investigations of the SOFC cathode confirmed the presence of small Cr-deposits but found no evidence for Cr-containing secondary phases with Pr or Ni. This suggests a high chemical stability of PNO against Cr-poisoning.