Characterization of $La_{0.65}Sr_{0.0.3}Cr_{0.85}Ni_{0.15}O_{3-\delta}$ based solid oxide electrolysis cells

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Development of solid oxide electrolysis cells (SOEC) are one of the most promising technologies to produce either hydrogen through water splitting or syngas through steam and CO_2 co-electrolysis mode when excess electricity is available. Hydrogen electrodes of solid oxide electrolysis cells (SOEC) are typically made of Ni-YSZ or Ni-GDC cermet. Despite having excellent catalytic activity Ni-based electrodes suffer from poor redox stability and Ni volatility [1]. $La_{0.65}Sr_{0.3}Cr_{0.85}Ni_{0.15}O_{3-\delta}$ (LSCN) mixed ion-electron conducting (MIEC) perovskite has been proposed as promising hydrogen electrode material for solid oxide electrolysis cells (SOEC) because of its excellent catalytic properties and good conductivity. In this study SOEC single cells were prepared using LSCN hydrogen electrode and $(La_{0.6}Sr_{0.4})_{0.95}Co_{0.2}Fe_{0.8}O_{3-\delta}$ (LSCF) air electrode [2, 3].

Studied cells were prepared using 19 mm 10Sc1CeSZ electrolyte substrates. Dense 6 μm thick $Ce_{0.9}Gd_{0.1}O_{1.95}$ (GDC) layer was screen printed to both sides of the cell to prevent formation of insulating $SrZrO_3$ layer. GDC layer was sintered to the electrolyte at 1300°C for 10h. 0.52cm^2 50%LSCN/50%GDC porous hydrogen electrode and LSCF oxygen electrode was prepared using screen printing method. Finally, cells were characterized using electrochemical impedance spectroscopy (EIS).

Impedance spectroscopy analysis showed that cells with 50%LSCT/50%GDC hydrogen electrode sintered at 1250°C and LSCF oxygen electrode had high current densities, reaching 0.93 A/cm^2 at 1.4V and 870°C with 45% water in hydrogen electrode compartment. During long term stability test temperatures were varied with 10°C step between 870°C and 830°C. Nyquist plots measured during the long-term test were modelled, R_{HF}, R_{LF} and E_{act} for the limiting processes were calculated.

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