While Ni/YSZ cermet electrodes are considered state of the art anodes in SOFC applications, the extraction of kinetic data from such electrodes is challenging due to convolution of reaction kinetics and transport phenomena. Employing micropatterned Ni thin film electrodes provides an elegant method for direct measurement of fundamental electrochemical properties.

In this study such Ni pattern electrodes were used to investigate the effect of H₂S in the H₂/H₂O/balance Ar atmosphere on the polarization resistance and capacitance. Additionally, influences on the capacitance are discussed.

Sample preparation & Measurement

- Screen printing and sintering of a NiO/YSZ cermet counter electrode on the back side of the substrate
- Deposition of 1200 nm Ni via magnetron sputtering followed by recrystallization at 750 °C
- Structuring of the film via photolithography & chemical etching
- Resulting microelectrodes are non-porous with a well-defined geometry (Fig. 1)
- Measurement in ‘MiMa’ setup (Fig. 2)

Electrochemical Characterization

- Measurement conditions
  - 750 °C
  - 2.5% H₂/2.5% H₂O/balance Ar atmosphere
- Fitting of electrochemical impedance spectra with a simple equivalent circuit (Fig. 3)
- After an initial drift stable polarization resistance and capacitance values can be obtained (Fig. 4)

Sulfur poisoning

- Adding 10 ppm H₂S to the gas feed rapidly increases the polarization resistance and significantly decreases the capacitance
- Both values partially return to their original values after removal of H₂S
- Resistance behavior is qualitatively equivalent to cermet electrodes [1]

Capacitance

- Absolute values too high for electrochemical double layer [2]
- Significant changes of C upon H₂S addition (Fig. 5) and temperature and bias-variation (Fig. 6) further contradict classical double layer capacitance
- Findings suggest chemical capacitance at the Ni/YSZ interface

Conclusion

- The polarization resistance changes upon addition/removal of H₂S gas feed are qualitatively equivalent to findings on cermet electrodes. These data can be used for modelling sulfur poisoning in cermet electrodes.
- Temperature, bias and H₂S-dependency of the capacitance indicates a chemical capacitance of the Ni electrode. This may lead to further understanding of the hydrogen oxidation reaction mechanism.

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References