IN OPERANDO ELECTROCHEMICAL HIGH-TEMPERATURE X-RAY DIFFRACTION STUDY OF Ni-$Ce_{0.9}$ $Gd_{0.1}O_{2-\delta}$ REDOX PROPERTIES

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Typical anode materials for solid oxide fuel cells (SOFC) are Ni-cermets. In the case of Ni-cermet materials NiO is reduced to Ni before the anode is ready for work. During reduction process the solid phase volume of an anode decreases approximately 40%. Due to either system malfunction or contamination, air (oxygen) might diffuse into anode compartment and cause Ni reoxidation to NiO. Reoxidation of Ni might also take place if after cell operation fuel gas flow is stopped in order to decrease fuel cell upkeep costs or if the electric load for the cell is too high and oxide ion flux through the membrane creates too oxidative environment at Ni catalyst [1]. During this processes the solid phase volume of an anode increases 66% [2,3]

The impact of polarization (i.e. O^{2-} ion flux through the membrane) and oxygen partial pressure (pO_2) on structure of $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ (GDC) in Ni-GDC cermet anode as well as redox stability of Ni particles has been studied with the in house developed *in operando* EC-HTXRD cell. O^{2-} current through the membrane lead to oxidation of Ce^{3+} to Ce^{4+}, which causes decrease of unit cell volume of GDC lattice. The observed change in lattice parameter initiated by polarization change from open circuit voltage (OCV) to 0.9V was equal to 50 degree temperature change, which means that GDC should not be polarized instantly, as it causes too rapid lattice parameter changes.

References:

[1] D. Waldbillig, A. Wood, D.G. Ivey, Thermal analysis of the cyclic reduction and oxidation behaviour of SOFC anodes, Solid State Ionics. 176 (2005) 847–859. doi:10.1016/j.ssi.2004.12.002.
[2] T. Klemensø, C. Chung, P.H. Larsen, M. Mogensen, The Mechanism Behind Redox Instability of Anodes in High-Temperature SOFCs, J. Electrochem. Soc. 152 (2005) A2186. doi:10.1149/1.2048228.
[3] A. Faes, A. Hessler-Wyser, A. Zryd, J. Van Herle, A review of RedOx cycling of solid oxide fuel cells anode, Membranes (Basel). 2 (2012) 585–664. doi:10.3390/membranes2030585.

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