Study of Ni-$Ce_{0.9}$ $Gd_{0.1}O_{2-\delta}$ redox properties using *operando* high temperature X-ray diffraction simultaneously with electrochemical impedance analysis

O. Korjus[1], J. Aruväli[2], K. Kirsimäe[2], I. Kivi[1], M. Kodu[3], E. Lust[1] and G. Nurk[1]

[1]*Institute of Chemistry, University of Tartu, Ravila 14a Str., Tartu 50411, Estonia*

[2]*Institute of Ecology and Earth Sciences, University of Tartu, Ravila 14a Str., Tartu 50411, Estonia*

[3]*Institute of Physics, University of Tartu, W. Ostwald 1 Str., Tartu 50411, Estonia*

e-mail of presenting author: ove.korjus@ut.ee

Sate of art anode materials for solid oxide fuel cells (SOFC) are Ni-cermets, either Ni/yttria stabilized zirconia (Ni-YSZ) or Ni/gadolinia doped ceria (Ni-GDC) [1]. In the case of Ni-cermet materials before the anode is ready for work NiO is reduced to Ni. During reduction process solid phase volume of anode decreases approximately 40%. Due to either system malfunction or contamination, air (oxygen) might diffuse into anode compartment, which causes Ni reoxidation to NiO. During this process anodes solid phase volume increases 66% [1,2]. Ni reoxidation might take place when after cells operation fuel gas flow is stopped in order to decrease fuel cell upkeep costs [3]. This causes reoxidation cycles during fuel cell's lifetime. Reoxidation of Ni might also occur if electric load for the cell is too high and oxide ion flux through the membrane creates too oxidative environment to Ni catalyst.

In order to understand the dynamics of redox processes and to design the Ni-GDC electrodes with optimal microstructure the information related to simultaneous structural and electrochemical changes during SOFC operation would be very useful. In this work a novel approach for simultaneous monitoring of electrochemical (EC) properties and crystallographic structure in operating SOFC i.e. *operando* SOFC EC-XRD measurement cell has been proposed and applied to understand the redox dynamics in Ni-GDC anode.

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. Klemenso, 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 et al. A review of RedOx cycling of solid oxide fuel cells anode, Membranes (Basel). 2 (2012) 585–664.

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks