The long-time electrical conductivity measurements of the Ni-cermet anode substrates (Forschungszentrum Jülich GmbH) were performed by a four-probe DC method at temperatures of 700 and 800°C with the composition of the gas mixture of 80% of water and 20% of hydrogen. At such experimental conditions a strong degradation and changes as well in electrical properties as in microstructure were expected. The total gas flow rate was 5 l/h (1 and 4 l/h for hydrogen and water, respectively).

The dependence for 800°C is described by the sum of two decaying exponential functions. One decay exponent was used for the data description at 700°C. From the results of the fitting can be assumed that the degradation is higher at higher temperature. At 800°C the infinite relative resistance value (time → ∞) is about 2.3-2.9%, higher than the initial value and only about 1.2% higher in case of 700°C. Comparing relaxation times, the observed rate of degradation processes is also higher at higher temperature. One can assume from these data that the degradation is, most probably, a thermally activated process(es). In order to further clarify the possible nature of the degradation process(es) in the substrates it is necessary to examine the Ni-cermet microstructure at initial state and the time evolution of microstructure during the course of degradation.

A6.47 Carbon Deposition and Sulfur Poisoning in Mo-Containing Anode Materials for SOFCs Studied in CO and CH₄ Fuels Kun Zheng and Konrad Swierczek; AGH University of Science and Technology, Faculty of Energy and Fuels, Kraków, Poland.

Development of SOFCs fueled by non-hydrogen fuels or syngas is of high importance, as usage of such fuels, e.g. methane, can significantly reduce costs, and therefore, can accelerate commercialization of SOFC technology [1-4]. For cells running on non-hydrogen fuels, on the commonly used Ni-YSZ cermet anode, carbon deposition can occur, which considerably decreases performance and causes problems with stability. Sulfur poisoning on the anode is also detrimental, as the considered fuels usually contain sulfur impurity. Recently, A₃MmO₆₋ₓ (A: Sr, Ba; M: 3d metals) perovskite-type oxides were considered as candidate anode materials for cells fueled with such fuels [1-4]. However, tolerance mechanism of carbon deposition and sulfur poisoning in these materials is still under intense research [1, 2].

In this study, Mo-containing SrₐFeₓₓ₋ₚMnₓO₅₋ₚ perovskites were proposed as novel electrode materials for symmetrical SOFCs (i.e., cells, in which identical materials are applied on anode and cathode). In such constructed cells, deposited carbon and adsorbed sulfur can be potentially removed by switching of the working mode between anode and cathode. Physicochemical and electrochemical properties of the proposed anode materials were systematically investigated, and carbon deposition, as well as sulfur poisoning tolerance were studied in CO, CH₄ gases and H₂S-containing atmospheres. Elucidation of poisoning mechanisms in SrₓFeₓ₋ₓ₋ₚMnₓ₀ₓ₋ₚ-based anodes is also given.

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A6.48 Model-Composite Electrodes as a Tool to Evaluate Alternative SOFC Anode Materials and Their Sulphur Poisoning Behaviour Matthias Grassl¹, Michael Doppler¹, Marco Brandner¹, Martin Bram¹, Jürgen Flegl¹ and Alexander K. Opitz²; ¹Electrochemistry, Vienna University of Technology, Wien, Austria; ²Electrochemistry, Vienna University of Technology, Vienna, Austria; ³Innovation Services, Plansee SE, Reutte, Austria; ⁴Institute of Energy and Climate Research, Forschungszentrum Jülich GmbH, Jülich, Germany.

From a materials science point of view two of the most important issues in the ever advancing development of efficient solid oxide fuel cells (SOFCs) are the optimization of both electrodes. SOFC anodes still rely on nickel yttria stabilized zirconia (YSZ) cermet structures for the fuel oxidation reaction and also, in the case of hydrocarbon fuels, for steam reformation catalysis. However, minute quantities of H₂S in the fuel gas cause a dramatic increase in the anode polarization resistance of Ni/YSZ, which is only partially explained by adsorption of sulphur. Therefore, the quest is on to, on the one hand, fully understand the mechanism behind sulphur poisoning in the classic Ni/YSZ cermet electrode, which might point to ways to mitigate its adverse effects on SOFC performance. On the other hand, alternative materials may also be a way to improve sulphur tolerance and consequently lifespan of an SOFC.

In this contribution we present results of impedance spectroscopy studies on geometrically well-defined model-composite electrodes, which allow us to separate elementary processes such as ionic and electronic conductivity, chemical capacitance as well as the surface reaction resistance. Keeping the general two component system of the Ni/YSZ cermet electrode we replaced the ion conducting YSZ phase by gadolinium doped cerium oxide (GDC) and the electron conducting Ni phase by, e.g. donor doped strontium titanate or buried Pt current collectors. These GDC/Pt, STO/GDC and STO/GDC/Pt model-composite electrodes could then be compared to Ni/YSZ and Ni/GDC cerments, which are more common as SOFC anodes.

Finally the effect of sulphur poisoning is evaluated regarding its impact on the surface and bulk defect chemistry in the above mentioned model systems.

A6.49 Electrical Conductivity and Redox Behavior of Donor and Acceptor Co-Substituted SrTiO₃ as Fuel Electrode Material Aleksy Yaremenchenko, Javier Macias and Jorge Frade; CICECO, Department of Materials and Ceramic Engineering, University of Aveiro, Aveiro, Portugal.

Donor-doped strontium titanate exhibits outstanding redox stability combined with sulfur tolerance and resistance to carbon deposition, and, therefore, is considered as promising ceramic component of composite fuel electrodes for solid oxide fuel/electrolysis cells. However, its electrical conductivity is on the level of 10 Scm⁻¹ under prospective operation conditions, implying significant current collection limitations. Furthermore, in-situ reduction of electrode layers often requires comparatively long treatments due to nearly frozen defect equilibrium in perovskite lattice of donor-doped SrTiO₃, and slow conductivity relaxation at temperatures ≤ 1000°C. Although high conductivity can be attained by pre-firing at high temperatures under very reducing conditions, this is probably a metastable state, undergoing long-term degradation in operating conditions. Recent computer calculations predicted that donor- and acceptor-type co-substitutions should induce mixed ionic-electronic conductivity in strontium titanate; this can be expected to facilitate the kinetics of re-equilibration on redox cycling. The present work was focused on the effect of co-substitution in SrₓPrₓ₋ₚTi₁₋ₓ₋ₚA₀ₓ₋ₚ (M = Mg, Al, Ga, Fe, ...). The characterization of materials included structural and microstructural studies, electrical conductivity measurements as function of temperature, oxygen partial pressure and pre-treatment conditions, and controlled-atmosphere thermogravimetric analysis. The emphasis was on the level of electrical conductivity and redox behavior, including the relaxation of conductivity and oxygen nonstoichiometry in redox cycling.

A6.50 Chemical Compatibility of Doped Yttrium Chromite and Ceria Composite Anode with YSZ Electrolyte Kang Yan¹, Haruo Kishimoto¹, Katherine D. Bagattino¹, Katsuhiko Yamaji¹, Teruhisa Horita¹ and Harumi Yokokawa¹; ¹National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan; ²the University of Tokyo, Tokyo, Japan. YₓCrₓ₋ₓ₋ₚO₃₋ₚ (YCCO) oxide is one of potential anode materials for using coal syngas as fuel in SOFC, because it has high electrical conductivity, high redox-stability and good tolerance to S-poisoning. However, similar to the well-known chromite-based materials LaₓCrᵧ₋ₓ₋ₚO₃₋ₚ (LCC), the YCCO has chemical reaction with electrolyte of