Novel Processing of Composite Cathodes for Proton Ceramic Fuel Cells by Exsolution

Laura Rioja-Monllor[1], Carlos Bernuy-Lopez[1], Marie-Laure Fontaine[2], Tor Grande[1] and Mari-Ann Einarsrud[1]
[1] Department of Materials Science and Engineering, Norwegian University of Science and Technology, 7491 Trondheim, Norway
[2] SINTEF Materials and Chemistry, 0314 Oslo, Norway

This work focuses on development of new composite cathode materials for $BaZrO_3$-based proton conducting fuel cells by a novel exsolution method. The cathodes were initially prepared via in situ oxidation driven decomposition of a single phase precursor described by the following nominal compositions:

$$La_{0.3}Ba_{0.7}Zr_{0.4}M_{0.6}O_{2.75} + O_2 \rightarrow 0.6La_{0.5}Ba_{0.5}MO_{3-\delta} - 0.4BaZrO_3$$

where M is Mn, Fe and/or Co. The single phase precursor ($La_{0.3}Ba_{0.7}Zr_{0.4}M_{0.6}O_{2.75}$) was synthesized by a modified Pechini route. The synthesis was optimized by a systematical study of the fuel/oxidant ratio, pH of the solution and thermal treatment in order to obtain an amorphous solid state precursor. The phase composition upon further thermal processing was defined by controlling the oxidation state of cobalt. The precursor was heated at 900 °C in air in order to achieve a composite consisting of a $La_{1-x}Ba_xCoO_{3-\delta}$–and a $BaZrO_3$-based material. *In situ* HT-XRD in air enabled to identify the formation mechanisms of the composites. For example the single phase precursor with M=Co formed in reducing atmosphere was exsoluted into the composite "$La_{1-x}Ba_xCoO_{3-\delta}$ - $BaZrO_3$" at ~800 °C. Characterization of the exsoluted composites includes electrical conductivity, microstructure and electrochemical properties by impedance spectroscopy. Electrochemical characterization as cathodes in symmetrical cells shows promising results. A discussion of the electrochemical characterization of the composite materials as a cathode for PCFC will be presented with the focus on the effect of varying M.