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Characterization of Ni-BZY anodes for Proton Ceramic Fuel Cells (PCFCs) - Novel nitrate-free combustion route

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One of the more promising possibilities for future "green" energy generation is the solid oxide fuel cell (SOFC). SOFCs offer a low-pollution technology to generate electricity electrochemically with high efficiency. Reducing the SOFC operating temperature in the 500-700°C range is desirable to reduce fabrication costs and overall improve performance [1]. This aim can be achieved by using Proton Ceramic Fuel cells (PCFCs). PCFCs offer a further advantage that they form water at the cathode and hence the fuel does not become diluted during cell operation. The study of PCFCs is in its infancy and currently only a few methods have been developed to prepare suitable anodes. Typically, cermet anodes like Ni-$BaCe_{(8-x)}Zr_xY_{0.2}O_{3-\delta}$ [2] or Ni-$SrCe_{(1-x)}Y_xO_{3-\delta}$ [3] and Ni-$BaZr_{(1-x)}Y_xO_{3-\delta}$ [4] have been prepared by mechanical mixing or combustion route by using their nitrate precursors. In the current work a novel, efficient and low cost nitrate free combustion route is developed to prepare Ni-$BaZr_{0.85}Y_{0.15}O_{3-\delta}$ cermet anodes for PCFCs. Nickel acetate and 30% H_2O_2 were used as starting precursors for the combustion reaction into which pre-prepared BZY powders were dispersed.

The advantages of this nitrate-free combustion method have been demonstrated by comparison to a more common nitrate/glycine combustion route. The results demonstrate that use of the nitrate-free precursors is essential to avoid partial decomposition of the pre-prepared BZY phase. Employment of the more common nitrate based precursors, due to their acidic nature, results in removal of Ba from the perovskite phase and formation of $Ba(NO_3)_2$, subsequently leading to the presence of BaY_2NiO_5 in the final product [5]. The impact of Ni–BZY phase purity on resultant polarisation behaviour has been assessed as a function of water vapour and oxygen partial pressures for electrodes of comparable microstructure. Partial decomposition of the perovskite phase limits performance by increasing the higher frequency polarisation resistance and this phenomenon is suggested to be associated with impaired proton transport in the oxide cermet phase.

The effect of porosity on polarisation behavior in the Ni-BZY cermet has been examined by varying the starch content (0wt%, 5wt%, 10wt% and 20wt %) as a pore former. Four symmetrical anode/electrloyte/anode cells (0wt%, 5wt%, 10wt% and 20wt % of starch) were prepared by co-pressing technique and these were used for electrochemical measurements. The anode of lowest porosity (no starch) has the lower polarisation resistance (Rp). By increasing the porosity Rp increased dramatically, Fig. 1. Thus, increases in porosity, over that provided by solely Ni reduction, are shown to be detrimental to anode performance, Fig. 2. This behaviour contrasts strongly to that observed in oxide-ion conducting SOFC Ni-cermet analogues.

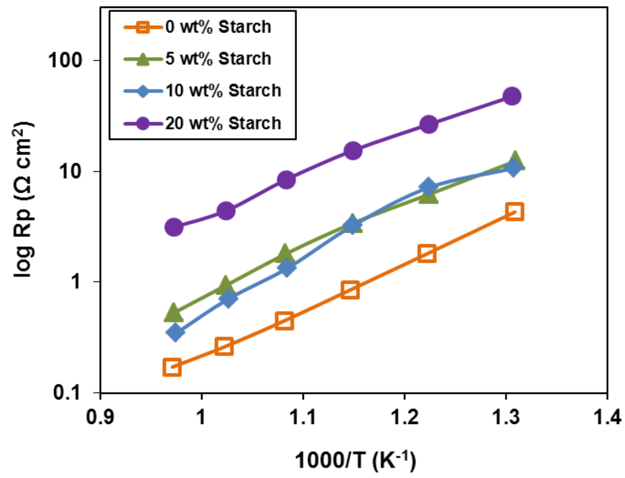

Figure 1: Temperature dependence of total polarisation resistance (Rp) of Ni-BZY with different starch content in wet 10% H_2/N_2

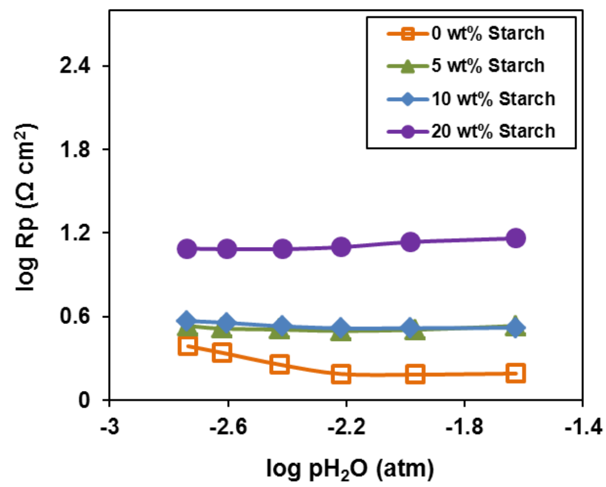

Figure 2: Comparison of total polarisation resistance (Rp) of Ni-BZY (using different starch content) with pH_2O in 10% H_2/N_2 at 600 °C

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References

[1] E. Fabbri, D. Pergolesi, E. Traversa, Chem. Soc. Rev., 39(11), (2010) 4355.
[2] S. J. Song, J. H. Moon, T. H. Lee, S. E. Dorris, U. Balachandran, Solid State Ionics, 179, (2008) 1854.
[3] G. C. Mather, F. M. Figueiredo, J. R. Jurado, J. R. Frade, Solid State Ionics, 162, (2003) 115.
[4] L. Bi, E. Fabbri, Z. Sun, E. Traversa, J. Electrochem. Soc., 158(7), (2011) B797.
[5] N. Narendar, G. C. Mather, P. N. Dias, D. P. Fagg, RSC Adv., 3, (2013) 859.