THE IMPACT OF WOOD DERIVED GASIFICATION GASES ON NI-CGO ANODES IN IT-SOFCS.

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The impact of gases arising from the gasification of wood chips on the performance of an intermediate temperature solid oxide fuel cell (IT-SOFC) has been assessed.

Wood chip gasification has been identified as a significant source of gaseous biofuels for heat and electricity generation. Its composition is 40-50% N_2+ 22-27% CO + 15% H_2 + 10-15% CO_2 + 2-3% CH_4.

SOFCs are likely to possess a greater level of tolerance to such biofuels, as well as providing the opportunity for internal reforming. Furthermore, operating at intermediate temperatures (500-700^{o}C) offers many advantages such as a reduction of the fuel cell cost and, more significantly, it is well suited to thermal integration with the gasification process.

The anode material used was a 60:40 wt% Ni:CGO-10 ($Ce_{0.9}Gd_{0.1}O_{1.95}$) cermet and was tested in a cell configuration in various gas atmospheres from diluted hydrogen to emulated gasification mixtures containing H_2, N_2, CO, CH_4 and CO_2. Experiments were performed at atmospheric pressure at T = 650^{o}C. Steady state current-voltage characteristics of the cell were obtained and complex impedance plots were acquired.

It was found that although CO behaved as a fuel it limited the performance of the cell as compared to H_2. As evident from figure 1, the low frequency (LF) response might be associated to a gas phase process and is directly proportional to the gas phase diffusion coefficient. In effect, the impedance LF arc was 4 times larger with moist 25% CO/N_2 than with moist 25% H_2/N_2 which is consistent with the fact that the CO binary diffusion coefficient is 3.6 times slower than that of H_2. This results highlights the need for a porous anode.

On the other hand, the presence of 10% CO_2 in the fuel did not significantly affect the cell performance as illustrated in figure 2, which shows the anode overpotential for various fuel gas compositions.

Finally, experimental I/V characteristics in moist H_2/N_2 mixtures were found to agree with theoretical data obtained from a model, which enables the leakage current due to the partial reduction of the CGO electrolyte to be quantified (see figure 3). The leakage current was predicted to be 0.05 A cm^{-2} at open circuit under the conditions used.

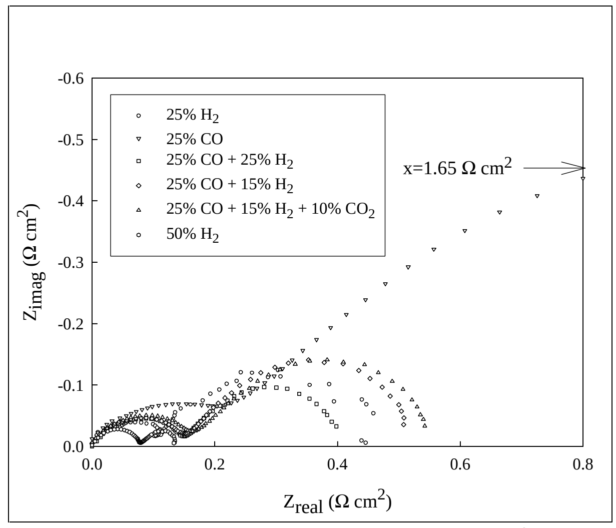

Figure 1. Cole-Cole impedance plots at T=650^{o}C under 20 mA cm^{-2} in various fuel mixtures of N_2, H_2, CO and CO_2 + 2.3% H_2O / air.

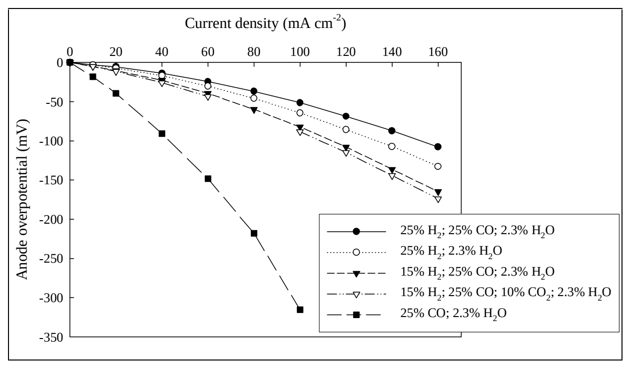

Figure 2. Impact of various H_2, CO and CO_2 concentrations on the anode overpotential. T=650^{o}C. Diluent gas: N_2. Oxidant: air.

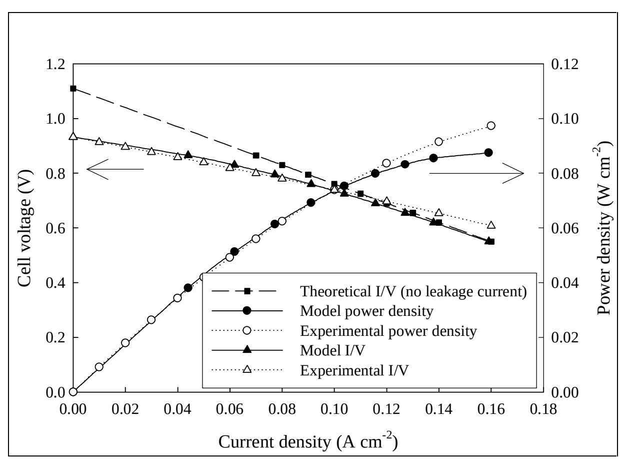

Figure 3. Comparison of the experimental and modeled current voltage characteristics of the cell at 650^{o}C with air as the oxidant and 50% H_2/N_2 + 2.3% H_2O as the fuel. Also shown is the theoretical Nernst voltage. Model parameter values: L=550 μm; T=923K; R_i=1.8 Ω cm^2; R_a=1.5 Ω cm^2; R_c=0.2 Ω cm^2; $pO_2(c)$=0.2 bar; $pO_2(a)$=1.14E^{-25} bar; P(-)=3.25E^{-24} bar.