Electrodes for Oxidation of Methane

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Introduction: Converting hydrocarbons in a solid oxide fuel cell (SOFC) have proved to be tricky (1). In general high $R_p$ values are obtained and a low stability of the electrodes is observed (2). Attempts have been made to improve the performance and stability of the anodes by using a composite of copper and ceria (a known carbon oxidation catalyst (3)). It has been shown possible to fabricate composite anodes, which gives a fair performance and are stable for prolonged periods of time in i.e. methane (4). This work presents some preliminary results obtained using different types of oxide-based electrodes for the conversion of methane. It is shown that the electrodes containing ceria show good ability with respect to ageing, but that the $R_p$ values (typically around 1 $\Omega$cm$^2$ at 1000°C for the best electrodes) obtained are much to high for practical applications.

Experimental: The electrodes were fabricated using standard ceramic processing and slurry spraying. The electrodes were sprayed onto Risø three electrode pellets. The measurements were done using a three-atmosphere setup. As a reference gas air was used and nitrogen was used as the surrounding atmosphere. The electrochemical characterisation is performed using a combination of a Solartron 1250 frequency response analyser and a Solartron 1287 electrochemical interface. The measurements are performed within a frequency range 65500 Hz to 1 mHz with an amplitude of approximately 28 mV.

Results: Selected impedance spectres are shown in figure 1-3. In general 1-3 distinct arcs are observed in the spectres.

Discussion: In general the ASR values obtained in this study are much to high for practical applications. The best electrodes show an ASR of 1.2 $\Omega$cm$^2$ at 1000°C. The stability of the new alloy/YSZ and the new alloy/CGO are remarkably good. Only the ceria based electrodes showed long time stability under a flow of methane at OCV.

Conclusion: Electrodes with good stability in flowing methane at OCV has been fabricated. The best electrodes show an $R_p$ of 1.2 $\Omega$cm$^2$ and consist of a 50/50 % (w/w) mixture of CGO10 and a new alloy. The ceria-based electrodes are stable over a prolonged period of time in methane at OCV.

References:

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