A New Nanostructured Copper-Based Catalyst

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It is well-known that ceria-based transition metal (oxide) catalysts exhibit good redox characteristics. They can act both as hydrogen or oxygen storage capacitors. The particular behaviour depends on the reduction/oxidation state (level).[1] Also, it has been shown that if a reduced transition metal catalyst (e.g., Cu) is highly dispersed on CeO_2, reversible oxidation can take place at very low oxygen concentration already at room temperature. Based on these facts, we have checked the behaviour of this catalyst in PEM fuel cell applications: i) as a CO-resistant electrocatalyst for hydrogen oxidation reaction (HOR) and ii) as an electrocatalyst for oxygen reduction reaction (ORR) in the low temperature PEM fuel cells.

The Cu/CeO_2 electrocatalyst was prepared from nanostructured $Cu_xCe_{1-x}O_{2-y}$ precursor that may be less sensitive to CO poisoning than pure Pt and Pt-based alloys. Namely, this precursor has already been successfully used as a catalyst for the selective oxidation of CO in the excess of H_2.[2-4] The catalyst is reduced much easier with CO than with H_2, which enables it to oxidize CO with such a very high selectivity.
In the present paper, we demonstrate the electrocatalytic activity of this new Cu/CeO_2 catalyst in the hydrogen evolution (HER) and hydrogen oxidation (HOR) reactions as well as in oxygen evolution (OER) and oxygen reduction (ORR) reactions in comparison with a classic Pt/C electro catalyst.

The electrochemical activity with respect to HER, HOR, OER and and ORR was tested in two types of cells. Firstly, we used a laboratory-made three-electrode cell where the working electrode was carbon paper onto which a mixture of catalyst, teflon and carbon black had been deposited and cured at temperatures between 300 and 350^{o}C. Secondly, we deposited the active material on glassy carbon surface of a standard rotating disc electrode (RDE). In both cases acidic electrolytes were used.

The main results of electrochemical measurements are the following: i) The new Cu/CeO_2 catalyst exhibits good electrocatalytic activity in both hydrogen oxidation (HOR) and oxygen reduction (ORR) reactions; ii) The gas diffusion electrode prepared with Cu/CeO_2 catalyst behaves as the reversible electrode for hydrogen reactions (HOR and HER) with relatively high exchange current density iii) No copper dissolution is observed at anodic potentials which indicates important stabilisation of metallic copper when dispersed on CeO_2 substrate.

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References

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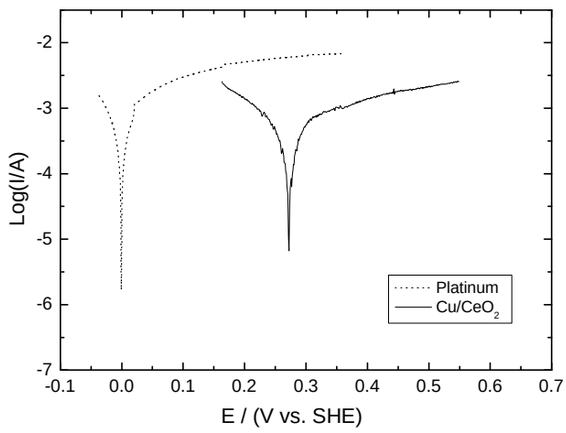

Figure 1. Comparison of polarization curves for the hydrogen reactions over the Pt/C and Cu/CeO_2 catalysts. Scan rate: 2 mV/s.

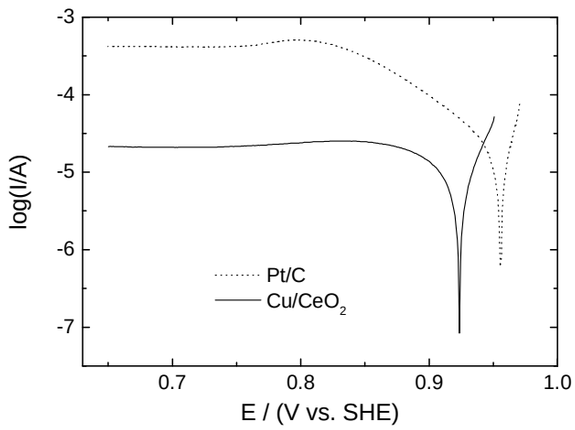

Figure 2. Comparison of polarization curves for the oxygen reactions over the Pt/C and Cu/CeO_2. Scan rate: 2 mV/s.