CATALYSTS FOR FUEL CELLS

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Introduction

The application of alkaline electrolytes in fuel cells is still interesting as alkaline electrolytes do not create so high corrosion problems. As a part of systematic research of low temperature fuel cells, the use of several forms of carbon carrier and their loading by electrocatalysts was studied.

Experimental

Carbonaceous materials used:

- Carbon black CHEZACARB SH (CHEMOPETROL Litvinov Inc.) marked as CL,
- Highly dispersed NANOSORBER (contains 10% fullerene or nanotubes) – marked as NS,
- Exfoliated graphite – marked as EG.

Electrocatalysts under investigation:

- Ni: nickel powder depositec in a slurru of carbon by sodium hypophosphite,
- Pt-A: Bubbling of hydrogen into a carbon slurry with addition of H_2PtCl_6,
- Pt-B: Carbon slurry with a solution of H_2PtCl_6 dried and heated to $400^{O}C$,
- H1: electrode material for metal hydride accumulator from CLAIO Poznań,

Procedure

The mixture of catalyst and PTFE powder were deposited on the tip of a disc rotation electrode (METROHM), which was controlled by a potentiostat AUTOLAB. Several scans in proper range of potential at constant rotation speed were recorded. The gas was led to the solution for 20 min. at least before start of measurements. Usually, scan No. 5 was taken in evaluation (in order to avoid any non-stationary effects on first scans). From all scans used, scans obtained under equal conditions in nitrogen-saturated electrolyte were subtracted. If necessary, Savitzky-Golay smoothing procedure of 4^{th} degree was applied. Finally, logarithmic waveform analysis was applied if possible. All routines were taken from AUTOLAB software. As general, 6 different scan rates were measured. Results obtained at lowest san rate 1 mV/s are reported here.
All potential values refer to a SCE electrode. 2M KOH was used as electrolyte.

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Results and Discussion

Reduction of oxygen (from air)

An example of NS material loaded by platinum (Pt-B) is shown in Fig. 1. A marked peak in the first section of the voltammogram is apparently caused by strong adsorption of molecular oxygen in pores of the material. Similar effect was observed on expanded graphite.
A diffusion-controlled process is quite clear from this data and the beginning of oxygen reduction starts at 0V.

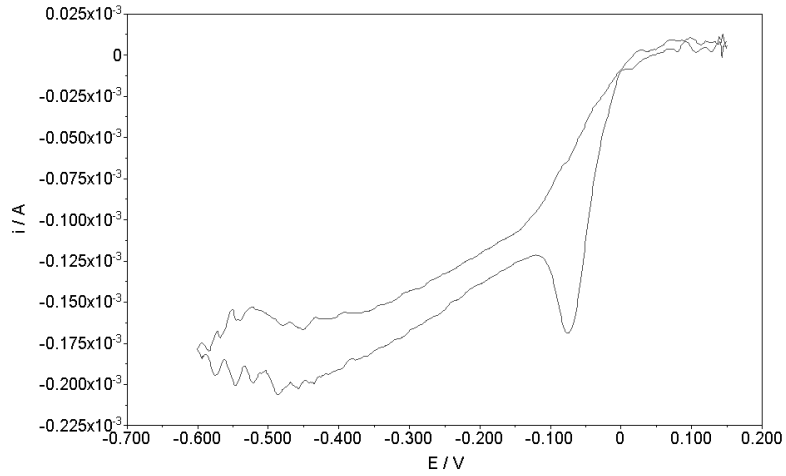

Fig. 1 *Reduction of oxygen on PT-B loaded nanosorb.*

Oxidation of hydrogen

The oxidation of hydrogen is much more difficult. Best results were obtained using catalyst Pt-B on Nanosorb (NS), as it is shown in Fig. 2. However, the difference of current in hydrogen and nitrogen is of the same order of magnitude (100 μA) as it corresponds to the solubility and concentration of oxygen and/or hydrogen.

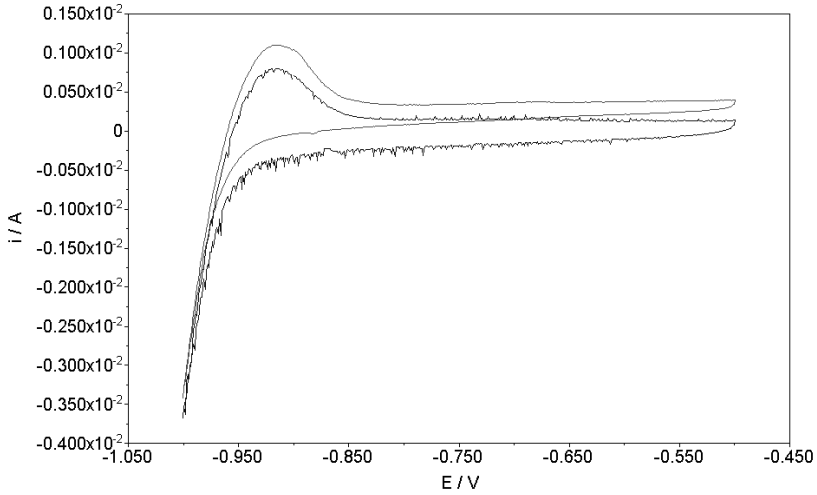

Fig. 2 *Comparison of polarisation curves on Pt-B loaded NS in electrolyte saturated by hydrogen (upper curve) and nitrogen (lower curve).*

Conclusions

In general, all catalysts and all carriers appeared as applicable in fuel cell oxygen cathode. Besides to platinum, several nickel impregnated catalysts appeared as prospective in application.

The results of hydrogen oxidation were much less optimistic. As a rule, only platinum containing materials were active in sufficiently broad potential range. The other materials were active at potentials close to the potential of hydrogen reaction and they suffered by passivation if potential was moved more positively than +400 mV against reversible potential of hydrogen. More activity in this direction should be concentrated in this direction.

Acknowledgements

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