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Investigation of the carbon monoxide resistance of platinum catalysts prepared *via* pulse alternating current technique

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Synthesis and characterization of platinum catalysts

For the preparation of Pt/Vulcan and Pt/CNT catalysts, two Pt electrodes of equal geometric area were immersed in the aqueous electrolytes (1M NaOH) and the electrodes were connected to an alternating current (AC) source operating at 50 Hz. The current density was 1 A cm^{-2}. In turn, the Pt electrodes were dispersed by the applied alternating current with symmetrical pulses. The platinum catalyst suspension was then filtered and the prepared material was rinsed with H2O to achieve neutral pH and dried at 80 ºC until its constant weight was obtained. Pt loading in Pt/C catalysts was 40±0.5 wt.%.
The TEM studies were carried out on a JEM-2100 (200 kV). Each sample for TEM analysis was prepared by depositing a drop of the catalyst suspension in hexane on the amorphous carbon-coated copper grid.
The synchrotron XRD measurements were performed in the Debye Scherrer geometry at the Swiss-Norwegian Beamlines (SNBL), ESRF (Grenoble, France) with a radiation wavelength of $\lambda = 0.69114$ Å using a 2D Pilatus 2M (Dectris) detector. The wavelength, sample to detector distance (95 mm) and resolution of the setup were calibrated using a standard sample of LaB6 powder (Standard Reference Materials 660a, National Institute for Standards and Technology, Gaithersburg, USA NIST). The samples were placed in glass capillaries (Hilgenberg GmbH) (0.7 mm diameter) with a wall thickness of 0.3 mm.

Carbon monoxide poisoning measurements

The study of carbon monoxide poisoning of electrocatalysts was carried out in a liquid gas diffusion half-cell in potentiostatic mode. In this case, the electrode was first supplied with pure hydrogen until a steady-state current value was obtained, and then with a mixture of H_2 + X ppm CO (X = 1 ppm, 5 ppm, 10 ppm), prepared using high-precision laboratory gas flow regulators ‘Bronkhost El-flow’. The current values were recorded after reaching the steady state at the potential value 0.1 V *vs.* RHE. The ratio of the current values in contaminated hydrogen to the steady-state current value in pure hydrogen was calculated.

The electrotransport characteristics measurements

Impedance spectra were recorded on an ‘Elins Z-500 PX’ impedance meter in the frequency range 0.014–0.5 MHz at the potential value 0.1 V vs. RHE. Up to two converging hodographs was taken at each concentration. The impedance hodographs were calculated using the ZView programme. The study of the nature of the interaction of electrocatalysts with carbon monoxide was carried out by impedance spectroscopy in a liquid gas diffusion half-cell, while a mixture of hydrogen and carbon monoxide, prepared using high-precision laboratory gas flow regulators ‘Bronkhost El-flow’, was fed to the working electrode. The errors in both AC and DC measurements were determined by the error in determining the geometric dimensions of the measured samples and amounted to 5%. All values of the electrochemical resistances (R_f) are given for a cell S = 0.385 cm^2. Pt loading was 0.4 mg_{Pt} cm^{-2}.