The Influence of Chloride Ions on Electrocatalytic Activity of Conducting Polymer/Pt Composite

Michal Kamradek and Petr Holzhauser

Institute of Chemical Technology, Prague, Czech Republic

Conducting polymer/Pt (CP/Pt) composites found significant application in the field of fuel cells where they are considered to be an alternative electrode material. Platinum serves as an electrocatalyst and poisoning of its surface can lead to decrease of the fuel cell efficiency. Despite the chloride ions sorption on platinum surface is well known effect, practically only the chlorocomplexes of platinum, $H_2[PtCl_6]$, $K_2[PtCl_6]$, $H_2[PtCl_4]$, $K_2[PtCl_4]$, $PtCl_4$, are used for CP/Pt synthesis. Together with the fact that chlorides are common impurity in drinking water there is a risk of decrease of electrocatalytic activity of composite in fuel cell. Yet the systematic study of this effect has not been done. The aims of this study are: (i) to find suitable, chloride free and commercially available platinum compounds which can be used for CP/Pt composites synthesis, (ii) to study the influence of the precursor on platinum particles morphology and (iii) to measure electrocatalytic activities of CP/Pt composites for methanol oxidation reaction (MOR) and for hydrogen oxidation reaction (HOR) and determine the influence of chloride ions on these activities. Composites based on polyaniline (PAni) and polypyrrole (PPy) were studied. The films were prepared electrochemically. Glassy carbon rotating disc electrode, area 0,196 cm^2, served as a support. PAni was synthesized using cycling voltammetry, PPy was prepared potentiostatically at the potential 1 V vs. SHE. Platinum particles were deposited galvanostatically and potentiostatically under different conditions from $K_2[PtCl_4]$, $K_2[Pt(ox)_2]$, $[Pt(NH_3)_4](NO_3)_2$ and $Pt(NO_3)_2$ water solutions. The samples with different amounts of platinum were characterized by scanning electron microscopy and by means of image analysis. Subsequently the electrocatalytic activities for MOR and HOR under different chloride concentration were measured. The activities for MOR were measured using cyclic voltammetry, activities for HOR were obtained by Koutecky-Levich analysis of potentiostatic polarization curves. It was found that the only compounds from which the platinum can be deposited on the PAni and PPy films are $K_2[PtCl_4]$ and $K_2[Pt(ox)_2]$. The morphology of obtained Pt particles differs strongly. The precursors $[Pt(NH_3)_4](NO_3)_2$ and $Pt(NO_3)_2$ are not suitable for Pt depositin on CP films. It was also found that chloride ions strongly decrease the electrocatalytic activity. Concentration of chloride anions 10^{-2} mol dm^{-3} leads to decrease of activity for HOR of about 50–70%. The influence of the chloride ions on the HOR on the PPy/Pt composites is dependent on the electrode potential. The influence of the chloride ions on the MOR is even more pronounced, in the presence of above stated chloride ions concentration the platinum surface is almost completely blocked and the MOR doesn't take place.