Study of Point of zero charge effect on oxygen reduction reaction at gas diffusionelectrode in PEMFCs

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Introduction:

The point of zero charge (pzc) is a concept relating to the phenomenon of adsorption, and it describes the condition when the electrical charge density on a surface is zero. In other words, pzc is (usually) the pH value at which a solid submerged in an electrolyte exhibits zero net electrical charge on the surface[1].

A catalyst in fuel cell is a special material that facilitates the reaction of oxygen and hydrogen and is usually made of platinum powder. The catalyst is rough and porous so that the maximum surface area of the platinum can be exposed to the hydrogen or oxygen[2].In this work, the effect of pzc on synthesizing process of platinum and cobalt on carbon electrocatalyst for Oxygen reduction reaction(ORR) were investigated. The prepared electrocatalysts can be used in low temperature fuel cell systems.

Experimental:

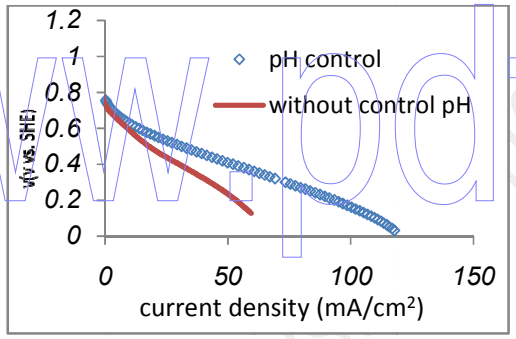
The Pt–Co electrocatalyst obtained in two steps, first by seeding 10 %(v/v) of the Pt–Co solution in graphite slurry and then by reduction of remaining Pt–Co solution (90%) in second step. After preparation of electrocatalyst, it was pasting on a carbon paper (CP)and used as electrode. The pzc was determined by acid-base titration.Liner Sweepvoltammograms(LSV)were obtainedunder O_2, at room temperature, at a scan rate of 1 mV/s in a 0.5M H_2SO_4 solution from 0.8 to -0.2 vs. Ag/AgCl.

ElectrochemicalImpedanceSpectroscopy (EIS)was taken in the frequency range of 100 KHz to 10 mHz.

Results:

In order to evaluationofpzc effect on evaluation ofPt-Co/Celectrocatalyst, two electrodes were prepared,one with the control of electrocatalystpH and the other without the control of pH (blank). The electrodes performance was evaluated by means of LSVand EIS, with three electrode system with an Ag/AgCl electrode as the reference electrode and a Pt electrode as a counter electrode.

The pzcs of Pt-Co/Celectrocatalyst and CP were determinedat pH values of 5 and 13 respectively.Therefore the pzc for CP coating with Pt-Co/C electrocatalystwas adjusted to pH equal to 8.5. On the other hand, it can be expected that in 5 < pH < 13 the surface of the Pt-Co/C is negatively charged while the one that of the CP is positively charged so in pH=8.5 CP and electrocatalysthad opposite charge.



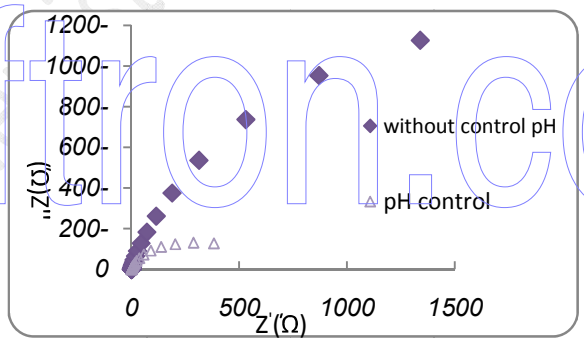


Fig. 1– LSV of prepared electrodes for ORRFig.2 Niquistplotsofprepared electrodes for ORR at OCV.

The LSV of two types of electrocatalyst are shown in the fig.1. As it was seen, the ORR current is increase with decreasing the potential, for both electrodes.But the electrode withthe pH control has higher current in all potential than blank sample(without pH control),i.e, the electrode has higher performancewhen the pH of electrocatalyst is adjusted to 8.5. Fig. 2 is shown the Niquist plots of the two samples. Both of them indicate an incomplete semi circle.But the diameter of electrode with control of pH is lower than the electrode without control of it. Since, the diameter of the semi circle is equal to the polarization resistance, so lowering the polarization resistanceshows better ORR activity and therefore, higher performanceachieved for electrode.According our results, we can say the preparation

condition of electrocatalyst influence on performance of prepared electrodes for ORR. In this work, the effect of pzc as a one of preparation parameter was studied.

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