Catalytic layers of proton exchange membrane fuel cell. Influence of structure and composition

V. Yu. Beloglazov
RRC "Kurchatov Institute"
Moscow Power Engineering Institute (Technical University)

Characteristics of proton exchange membrane fuel cell are substantially depend on composition and structure of electrodes. Catalytic layer of electrode is applied onto the surface of membrane or current collector and contains particles of the electrocatalyst and polymer electrolyte. In addition to activity of the catalyst, important parameters of FC electrodes are large surface of the reactionary zone (zone of contact of three phases — the catalyst, ion-exchange polymer and phase in which there is a reagent), resistance to electronic and ionic current, and also transport characteristics. According to percolation theory, in order to have good electronic and ionic conductivity of catalytic layer, two systems of contacting particles – catalyst and polymer electrolyte – should be created in the layer. Good mass-transport of gaseous reagents should be provided if a highly-branched system of pores.

In work great deal of experimental researches by determination of optimum composition of catalytic ink is carried out, electronic and ionic conductivity of catalytic layer are investigated.

By optimization of amount of the applied catalyst it is revealed, that dependence of productivity ТЭ on loading electrodes has a maximum. The further decrease of characteristics occurs basically due to ohmic losses of ionic current in system of the closed particles of polymer electrolyte.

Specific resistance of model catalytic layer in four-probe cell is investigated depending on percentage of polymer in catalytic compositions. Reduction of resistance of layer was observed at increase of ionomer content. The particles don't contact each other at low volume concentration and the catalytic layer doesn't conduct the ionic current. At growth of the polymer contents in layer reduction of specific resistance of a layer is observed.

For exception of influence of collateral processes in four-probe cell comparative experiments in electrolytic cell have been carried out. Thus it is possible to investigate ionic conductivity at large density currents. On the linear site of current-voltage characteristic resistance of a model layer is calculated.

Carried out researches have allowed to reveal the factors limiting productivity of the catalytic layer. The ratio of the layer components is optimized, the opportunity of decrease of the platinum loading at the set productivity of a fuel element is shown.