

Enzymatic catalysis in PEM electrochemical systems

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At present time proton exchange membrane (PEM) fuel cells and electrolyzers are developed worldwide for different applications. One of the main components of these systems, responsible for their efficiency and cost, is electrocatalytic layer. Today mainly platinum group metals are used as electrocatalysts for PEM systems. However the cost of noble metals is rather high and their natural resources are rather limited. Due to last one, it is expected that than large-scale production of PEM systems will start, the cost of platinum metals on the market should increase essentially. These facts restrain commercialization of fuel cells and electrolyzers. Thus there is the real necessity for development of non-platinum catalysts. Biological catalysts — hydrogenase and laccase — are one of the candidates for this role. Beside lower price such catalysts have another important advantage: they are not poisoned by CO and H₂S, presenting in cheap hydrogen used as a fuel for fuel cells.

The goal of present work was to investigate activity and stability of enzyme-based catalysts, both for hydrogen and oxygen reduction/evolution. Enzymes were immobilized onto pre-treated carbon electrodes by adsorption from diluted aqueous solutions. Hydrogenase electrodes have demonstrated hydrogen oxidation currents up to 2.3 mA/cm². The electrodes with hydrogenase and laccase were used for hydrogen and oxygen reduction in PEM fuel cell. The current density was up to 0.22 mA/cm² and open circuit voltage up to 1.17 V.

Thus, it was shown that enzymes could be potentially used as catalysts for PEM systems. This work was carried out within the framework of the federal scientific and technical program "Researches and development on priority directions of science and engineering development" of the Russian Federal Agency on Science and Innovations for 2002–2006 years (the government contract № 02.434.11.5003 dated June 1, 2005).

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