FORMATION OF THE PROTON EXCHANGE MEMBRANE

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During last decade one of the most actively researched topics in electrochemistry is improving of materials for electrochemical hydrogen generators with solid electrolyte in order to increase the electrolysis efficiency and reduce the cost of components [1]. Electrolytic cell contains two electrodes and a proton exchange membrane (PEM) forming a membrane electrode assembly. Although the cell is fed by distilled water, the pH of the media near the anode is around 1-2. The catalytic layers of electrodes usually contain nanoparticles of platinum group metals and their oxides, but membrane is still the most expensive component.

Membranes are required to have high proton conductivity, low electron conductivity, gas impermeability, high chemical and mechanical resistance. Currently the most widely used membrane is Nafion®, which is a copolymer of tetrafluoroethylene and comonomer with side chains of perfluorinated vinyl ether ending with sulfo group, so that proton is transferred from one sulfo group to another one. The review of scientific publications showed that a significant number of membranes that can replace Nafion® are developed, however, they can not meet all the requirements. We also made an attempt to produce a proton exchange membrane and chose polyvinyl alcohol and inorganic hydrates due to their cost [2].

The inorganic hydrate is proton-generating component. It is globular structure provides proton conductivity on the surface of the particles, since the globules surface contains numerous quantity of OH-groups, water molecules and ions trapped from solution. The surface particles being in contact with the solution have high mobility and can exchange ions. Water molecules in the intergrain media also have high mobility. Due to the acid nature of inorganic hydrates, the hydronium is formed in the intergrain media, which is involved in the protons transfer. However, as such hydrates are not mechanically resistant, the polymer matrix is needed to make a membrane. The polyvinyl alcohol (PVA) is used as polymer matrix, as it has its own system of hydrogen bonds, by which the protons can be transferred, and significant gas impermeability (10^{-13} $m^2/(s \cdot Pa)$ for hydrogen). However, PVA dissolves in warm water, so it is unacceptable for use in water media. Therefore, we cross-linked chains of PVA by aldehyde.

Dependences of physical and physicochemical properties of formed proton exchange membranes on their composition and formation conditions are obtained.

Literature:

1. PEM Electrolysis for Hydrogen Production: Principles and Applications / Dmitri Bessarabov, Haijiang Wang, Hui Li, Nana Zhao. - CRC Press, 2015. – 389 p.

2. Pat. № 103734 Ukraine, IPC B01D 71/02, B01D 71/06, H01M 2/14, C25B 1/04 (2006.01). Process of proton exchange membrane formation / A.A. Maizelis, B.I. Bairachny; applicant and holder of patent NTU “KhPI”. – № u201506664; appl. 06.07.2015; publ. 25.12.2015, Bul. N. 24.