PROCESSES AND MATERIALS IN ELECTROCHEMICAL ENERGY SYSTEMS

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Abstract

The habilitation thesis entitled "Processes and materials in electrochemical energy systems" presents the main scientific, professional and academic achievements of the author after defending the PhD thesis at the Politehnica University Timisoara, together with future plans for evolution and development of the research and university career. The main research directions of the author are part of the broad area of electrochemical energy systems, with special emphasis on electrocatalysis of hydrogen evolution reaction and electrochemical synthesis of conducting polymer films and study of charge transport mechanism within such films. The entire research activity is reflected in 71 publications, of which 29 papers published in ISI ranked journals (h-index 11), author and co-author of 3 books, co-author of 1 national patent, project leader of 3 research grants and member of 1 international and 10 national research projects. The electrocatalysis of hydrogen evolution reaction is a research direction initiated in the Laboratory for Electrochemistry, Corrosion and Electrochemical Engineering of UPT. The investigations aimed at accelerating the hydrogen evolution reaction by using electrocatalysts added in the solution. These catalysts, also called proton carriers, have the ability to increase the proton concentration in the electric double layer from the metal-solution interface by transporting protons from the bulk of the solution to the interface. Various aromatic or aliphatic amines were investigated as proton carriers, since the ability to carry protons is given by the lone pair of electrons of the nitrogen atom. The originality of our work reside in that we have shown that the catalytic effect of the proton carriers is manifested not only for electrode materials with high hydrogen overpotential, such as copper, but, more important from a practical point of view, even for electrodes with low hydrogen overpotential, namely gold and platinum. Also, we have explained the catalytic effect of the amines based on their molecular parameters obtained by modeling, the most important being the dipole moment and the surface coverage degree. Thus, the highest catalytic effect was obtained for amines with a low surface coverage, which is equivalent to a larger number of molecules present at the interface, so an

increased proton concentration, and respectively for a large dipole moment, which indicates a favorable orientation of the molecules at the interface, namely with the nitrogen atom and the attached proton directed towards the metal, where the charge transfer is greatly facilitated. Considering the expertise in electrocatalysis of hydrogen evolution reaction, our research group is partner and work package leader in a HORIZON 2020 project approved for financing from 2018: "Novel modular stack design for high pressure PEM water electrolyzer technology with wide operation range and reduced cost".

The full abstract at:
http://www.upt.ro/img/files/2016-2017/abilitare/kellenberger/Rezumat_teza_abilitare_en_Kellenberger.pdf

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