$AuCeO_2$/C – ENHANCED ELECTROCATALYTIC ACTIVITY FOR OXIDATION OF BOROHYDRIDE AND REDUCTION OF OXYGEN

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Conventional combustion-based technologies with high emission rates pose a significant threat regarding air pollution, health, and the climate. Their operation requires enormous natural resources that are not eternal. Therefore, the demand for alternative energy sources has mobilized scientists around the world to search for and research such energy sources. One of them is fuel cells, which can operate at higher efficiencies than combustion engines and can convert the chemical energy in the fuel to electrical energy with efficiencies of up to 60%; it is notable that fuel cells have lower emissions than combustion engines [1]. Different kinds of fuel cells such as direct alcohol fuel cells (DAFC), alkali fuel cells (AFC), direct borohydride fuel cells (DBFC), Proton Exchange Membrane fuel cells (PEMFC), Solid Oxide fuel cells (SOFC), and others have been investigated intensely within the past few decades. All of them have their advantages and disadvantages however the principle of their operation is similar - fuel oxidation on the anode side and oxygen reduction on the cathode side. Lately, the most attention has attracted DAFC, DBFC, PEMFC because the materials used in these fuel cells can be more easily produced, stored, and transported compared to the other fuel cells, making them more advantageous. DBFC has attracted the attention of researchers because of sodium borohydride (sodium borohydride anion BH_4^-) potential to generate extremely pure hydrogen on demand or just be directly oxidized in a DBFC. Moreover, the BH_4^- has higher volumetric (7314 $Whdm^{-3}$) and gravimetric (7100 $Whkg^{-1}$) energy density than methanol (4800 $Whdm^{-3}$) and (6000 $Whkg^{-1}$), respectively [2]. BH_4^- is also more stable in an alkaline medium (pH > 14) [3]. Additionally, an alkaline BH_4^- solution is easy and safe to transport and the final product BO_2^- anion (boric acid) of BH_4^- oxidation (BOR) is environmentally safe, relatively inert, and non-toxic. The oxygen reduction reaction (ORR) kinetics is facile under alkaline conditions. In the light of these advantages, DBFC technology is still attractive for investigation regarding its use as a potential power generator technology in energy systems [4].

This study presents electrocatalytic activity of the $AuCeO_2$/C and Au/C catalysts, prepared using microwave irradiation, toward sodium borohydride oxidation and oxygen reduction reactions in an alkaline medium. It has been found that the obtained $AuCeO_2$/C having Au loading and electrochemically active surface area of AuNPs equal to 71 μg cm^{-2} and 0.05 cm^2, respectively, showed enhanced electrocatalytic activity toward investigated reactions compared with the Au/C catalyst having Au loading and electrochemically active surface area of AuNPs equal to 78 μg cm^{-2} and 0.19 cm^2, respectively. The $AuCeO_2$/C catalyst demonstrated 4.5 times higher current density values for sodium borohydride oxidation compare with those at the bare Au/C catalyst. Moreover the onset potential of oxygen reduction reaction (0.96 V) on the $AuCeO_2$/C catalyst was very similar to commercial Pt/C (0.98 V).

References

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