Influence of the carbon support on the catalytic properties of selenide-based electrocatalyst for oxygen reduction reaction in an alkaline fuel cell

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Alkaline fuel cells (AFCs) represent perspective devices for the conversion of chemical energy stored in the hydrogen bond into electric energy. Their main advantages are high efficiency compared to competitive fuel cells and the possibility to use non-platinum materials for electrodes and catalysts which is associated with lower investment costs. However, the commercial alkaline fuel cells use typically expensive platinum-based catalysts for oxygen reduction reaction due to their high activity [1]. Alternatives to the platinum catalysts can be carbon-based catalysts, transition metal oxides or complex macrocycles [2]. Also, selenide-based materials represent promising cost-effective alternatives, not least due to their stability in alkaline environments, good electrocatalytic activity and simple preparation [3]. While these catalysts generally have low electrical conductivity and a small specific surface area, such drawbacks can be overcome by using proper catalyst support [3]. The most common catalyst supports represent carbon-based materials due to their abundance, low price, remarkable electric conductivity and high specific surface area [4]. The carbon-based materials are mostly used in form of carbon black, carbon nanotubes, graphite, graphene or graphene oxide [4].

Here, we describe the solvothermal synthesis of $Co_{0,83}Ni_{0,17}Se_2$ catalyst on the different types of the carbon support. As the carbon supports were selected: commercial carbon black Vulcan XC72R, graphite and graphene oxide. This study aims to investigate the influence of the different types of carbon support on the physical and electrochemical properties of the selenide-based catalyst. Also, the optimal ratio between carbon support and the catalyst was optimized. Physical properties were determined using X-ray diffraction, scanning electron microscopy, and energy-dispersive spectroscopy. The electrochemical performance of the catalyst was evaluated using electrochemical impedance spectroscopy and linear sweep voltammetry on the rotating disk electrode in 0.1 mol dm^{-3} KOH at 30 °C. Based on the results obtained, all the carbon supports have a positive influence on the physical properties of the catalysts.

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1. Ferriday, T.B. and P.H. Middleton, *Alkaline fuel cell technology - A review.* International Journal of Hydrogen Energy, 2021. **46**(35): p. 18489-18510.
2. Pan, Z.F., et al., *Advances and challenges in alkaline anion exchange membrane fuel cells.* Progress in Energy and Combustion Science, 2018. **66**: p. 141-175.
3. Zhao, Y., et al., *Selenium Decorated Reduced Graphene Oxide Supported CoSe2 Nanoparticles as Efficient Electrochemical Catalyst for the Oxygen Reduction Reaction.* ChemElectroChem, 2018.
4. Molina-García, M.A. and N.V. Rees, *Effect of catalyst carbon supports on the oxygen reduction reaction in alkaline media: a comparative study.* RSC Advances, 2016. **6**(97): p. 94669-94681.