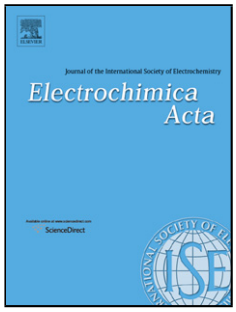

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Anion-selective materials with 1,4-diazabicyclo[2.2.2]octane functional groups for advanced alkaline water electrolysis

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Key words: Water electrolysis, alkaline environment, anion-selective membrane, 1,4-diazabicyclo[2.2.2]octane, DABCO

Abstract

In this study a novel alkaline polymer electrolyte membrane is presented, based on polystyrene-block-poly(ethylene-ran-butylene)-block-polystyrene (PSEBS) functionalized by the 1,4-diazabicyclo[2.2.2]octane (DABCO) to be used as an electrode compartment separator as well as a catalytic layer binder in the alkaline water electrolysis process with the aim to reduce the concentration of KOH in the liquid electrolyte and to allow the construction of an efficient zero gap-type cell. This material was selected due to the promising properties of both individual components resulting from their molecular structure. The prepared membrane was thoroughly characterized with regard to its stability in an alkaline environment. The prepared membrane showed an ion-exchange capacity value of 0.76 mmol $g^{-1}_{\text{dry membrane}}$ and ionic conductivity of 7.5 S m^{-1} at 30 °C. Excellent membrane durability was confirmed for a KOH concentration range up to 10 wt.% and temperature up to 50°C. Subsequently, the polymer electrolyte was tested in a laboratory alkaline water electrolyser using 10 wt.% KOH as a circulating medium showing promising current density of 150 mA cm^{-2} at 40 °C. In a 150-hour experiment the PSEBS functionalized by DABCO manifested very good stability and high potential for optimization for this process as it showed no signs of chemical degradation.

1 Introduction

Alkaline water electrolysis is a topic that has attracted renewed attention during the last decade. That is because it offers important advantages over proton exchange membrane (PEM) water electrolysis, an alternative process currently preferred for its high intensity and flexibility. The main reason lies in the fact that alkaline water electrolysis does not require utilization of precious metals (Pt, Ir) as electrocatalysts for the electrode reactions. On the other hand, alkaline water electrolysis suffers from the lack of an anion-selective separator able to separate the hydrogen and oxygen produced and at the same time to ensure sufficiently good ionic contact between the electrodes. Thus, nowadays industrial alkaline water electrolysers utilize a diaphragm-type separator. As a consequence, it is necessary to use a highly concentrated