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Enhancing the efficiency of alkaline water electrolysis by using ionic liquids as electrolyte additives

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Alkaline water electrolysis offers a possibility of producing hydrogen gas without consuming fossil fuels. Namely, the use of electricity from renewable energy sources makes the electrolysis process green and hydrogen gas a green energy carrier, enabling switching from carbon-based to green and sustainable energy sources. However, most of the global hydrogen is currently still produce by the steam reforming of fossil fuels [1]. Thus, increasing the efficiency of hydrogen and oxygen evolution reactions (HER and OER) is vital to make electrolysis economically viable and competitive to steam reforming. Research to improve the efficiency of the electrode reactions is mainly focused on developing novel electrocatalytic materials. Another approach to decrease the electrode reactions activation overpotential is use of electrolyte additives, such as room temperature ionic liquids (RTILs). RTILs can be tailor-made to increase their beneficial effect on the HER and OER kinetics. Improved HER kinetics in the presence of RTILs has been previously confirmed in both acidic and alkaline media [2,3]. The present work examines four new tailored RTILs having the same chloride anion, and methylimidazolium cation containing different alkyl chains. These include 3-ethyl-1-methylimidazolium chloride, 3-butyl-1-methylimidazolium chloride, 3-(2-methoxyethyl)-1-methylimidazolium chloride, and 3-(2-ethoxyethyl)-1-methylimidazolium chloride. The effect of the addition of small amounts (1 vol.%) of the listed RTILs on HER and OER kinetics in alkaline media (8 M KOH) is assessed using Pt electrodes. Cyclic voltammetry, linear scan voltammetry, and chronoamperometry are carried out at temperatures ranging from 25 °C to 80 °C. Evaluation of kinetic parameters was carried out and their values were compared with previously reported data. Finally, measurements of the volume of generated gas were done in a small-scale alkaline electrolyser to compare the gas production in pure 8 M KOH solution and after the addition of the chosen RTILs.

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