New membranes for CO_2 electrochemical reduction

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The use of CO_2 as a valuable feedstock to obtain new useful fuels and materials, such as CO, alcohols, formic acid and hydrocarbons, has become an important research field that can contribute to valuable strategies in carbon resource utilization, such as the Electrochemical CO_2 Reduction (ECR). The process is carried out in electrolyzers, which have a membrane as a key component to separate the two-half cells, with performance and sustainability strongly linked to membrane properties, including ionic conductivity, chemical and structural stability and permeability of products and incoming and generated gases [1].
The aim of this work is the preparation and evaluation of a series of doped cation conductive membranes for use in low temperature CO_2 electrolysis, for increasing efficiency and minimizing gas crossover. The new membranes were prepared by the incorporation of bisphosphonic acids dopants into the matrix of selected polymers: widely used Nafion, and a lower cost, non-fluorinated alternative, SPEEK. The choice of dopants is justified since their incorporation improved ion conducting properties of the membranes as well as their durability, as indicated in previous studies by the authors [2,3].
New membranes, with a 7x7 cm dimension, were tested in an optimized, two compartment, purposely build reactor for CO_2 reduction [4], employed to obtain syngas, operating at 45 °C, pressurized at 10 bar, using 10% EMIMOTf ionic liquid as electrolyte and 1437 C of charge. Membrane performance was compared with a PSFA-based Nafion-like commercial membrane, 10120-PK from Fumatech, used as standard and tested in the same experimental conditions. Electrolyses results using the new membranes are compared in terms of productivities of CO_2 reduced products, faradaic efficiencies, energy efficiencies and crossovers. These results showed that these membranes are a promising material for ECR.

Keywords: carbon dioxide; electrolysis; cation exchange membrane; bisphosphonic acids

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