Design of efficient co-electrolyser systems for CO_2 reduction in gas phase

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The electrochemical CO_2 reduction reaction (CO_2RR) is a complex reaction which must be carried out in a highly selective and efficient manner. Many efforts are being taken to develop catalysts with improved reaction selectivity and efficiency and significant progress has been made in this area of research [1]. However, CO_2RR kinetics, product identification and quantification are mostly carried out in half-cell configurations using liquid electrolytes. This fundamental approach of studying CO_2RR is limited by the low solubility of CO_2 in water, the maximum CO_2 reduction current reported in the literature is in the range of 0.01- 0.02 A/cm^2 [2]. In order to overcome the solubility problem and to reach higher operating current densities, CO_2 reduction can be carried out in a co-electrolysis system where pure or diluted gaseous CO_2 is used. Our research efforts were focused on the design of an electrochemical cell for co-elecrolysis operating at high-current densities with good product selectivity.

The experiments were conducted in a membrane electrolyzer-like configuration setup. Various gold type cathode electrode materials were tested and the reaction pH was controlled by using different type of commercial ionic exchange membranes. The reaction products were analysed by on-line mass spectroscopy. The co-electrolyser performance and the selectivities of the various membrane electrode assemblies are examined in detail.

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