CO_2 electroreduction to CO in a membrane electrode assembly cell configuration for process scaling up

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The electrochemical reduction of CO_2 is a challenging and promising opportunity to fight climate change and to reduce the greenhouse gas concentration in the atmosphere. In the previous work, Zeng et al. [1] deeply investigated the role of copper and antimony-based bimetallic catalysts, optimized the solvothermal microwave-assisted synthesis and greatly demonstrated the electrochemical selective CO production starting from a pure CO_2 feed. To understand how to translate research from laboratory scales (5 cm^2) to industrially relevant scale (>100 cm^2), this work analyzes different step conditions optimization during the scale up process. This work has the goal to optimize its performance in membrane electrode assembly cell configuration (MEA). Protocols optimizations concern both the catalyst preparation and the cell setup parameters. Regarding the catalyst optimization this work focused on how the ink preparation and the catalyst loading can affect the process selectivity. It was found that, a high catalyst loading and an anionic binder are necessary to obtain high CO production (FE_{CO}>90%). On the other hand, concerning the cell setup, to decrease the total cell voltage this work focused on the type of membrane, the electrolyte optimal concentration and the nature of the counter electrode (CE). IrOx-based CE was found to have greater performance with respect to Pt-based CE and a huge decrease in terms of potential (> 0.5V) was appreciated during CP=150 mA/cm^2. To conclude, interesting optimization results were obtained in order to scale up the process and reach TRL4-5. Future developments will concern the scale up to TRL6-7 and stability tests (>150h) to provide industries with an electrochemical cell for CO_2 transformation that ensures high reliability, durability, and selective production of CO.

[1] doi.org/10.1016/j.apcatb.2022.121089