**Electroreduction of CO2 to formate using carbon-supported Bi nanoparticles in Gas Diffusion Electrodes in a continuous mode**

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**Highlights**

* Formate was obtained in a continuous mode with a single pass in a filter-press reactor.
* Bi-GDEs were able to work at a current density up to 300 mA cm-2.
* At a 200 mA cm-2, 4 g L-1 of formate was obtained with a high faradaic efficiency (80%).
* Concentrations of formate of up to 18 g L-1 were obtained.

**1. Introduction**

Electrochemical reduction of CO2 is being considered as an interesting option to store energy from intermittent renewable sources in the form of chemical valued-added products. Among all the different valued-added products, formate is an attractive product used for several industrial applications and particularly, it has been highlighted as a promising fuel for low-temperature fuel cells and as renewable hydrogen carrier [1].

Our previous research on using Catalyst Coated Membrane Electrodes (CCMEs) using tin nanoparticles as catalyst [2] achieved formate concentration up to 19.2 g L-1 with a faradaic efficiency (FE) of 50%, a rate of 1.15 mmol m-2 s-1 and an energy consumption of 244 kWh kmol-1 of formate in the output stream of the electrochemical reactor. These results could be improved using Bi as a catalyst material in the cathode according to the growing number of promising results that point to the possibility of electroreducing CO2 to formate at lower potentials than other metals [3]. This communication is focused on the development of Gas Diffusion Electrodes using carbon-supported Bi nanoparticles (Bi-GDEs), operating in a continuous mode in a filter-press reactor.

**2. Methods**

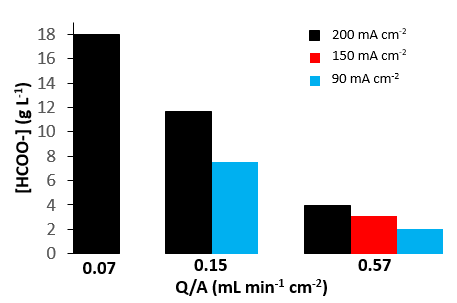
Bi-GDEs were prepared by depositing carbon-supported Bi nanoparticles over a Toray carbon paper, used as a carbonaceous support. In the filter-press cell, Bi-GDEs were used as the working electrode and a Dimensionally Stable Anode was used as the counter electrode, whereas an aqueous solution of KCl+KHCO3 and KOH is used as catholyte and anolyte respectively. A cation exchange membrane (Nafion 117®) divides the cathodic and anodic compartments in the cell. The concentration of formate is analyzed by ion chromatograph (Dionex IC 1100).

**3. Results and discussion**

Working with a electrocatalyst load of 0.75 mg cm-2 and electrode area of 10 cm2, different experiments were carried out at different current densities and electrolyte flow/area ratios for continuous electroreduction of CO2 to formate in the filter-press type cell, with only one pass of the electrolyte through the cell.

Working at a current density of 300 mA cm-2 and electrolyte flow/area ratio of 0.57 mL min-1 cm-2, a formate concentration of 5.2 g L-1 with a FE, rate and energy consumption of 70%, 11 mmol m-2 s-1 and 410 kWh per kmol of formate, respectively, were achieved. Decreasing the current density from 300 mA cm-2 to 200 mA cm-2, keeping the same value of electrolyte flow/area ratio, the formate concentration decreased to 4 g L-1 with a FE and rate around 80% and 8.3 mmol m-2 s-1.

Subsequently, the influence of electrolyte flow/area ratio was analyzed in order to obtain a formate product as concentrated as possible, as can be shown in Figure 1.



**Figure 1.** Formate concentration as a function of the current density and electrolyte flow/area ratio.

These results confirm that Bi-GDEs allow working in a continuous electrochemical reactor with higher current densities values compared with recent contributions in literature.

**4. Conclusions**

It is important to remark that these results were obtained working at higher current densities than previous studies reported in the literature, and they were also obtained in a continuous mode with only one pass of the catholyte through the filter press cell. These conditions are mandatory to remark the feasibility of the continuous electroreduction process using Bi/C-NPS in Bi-GDEs.,

**References**

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