

# Strategies for improving GDE performance by a uniform dispersion of catalyst nanoparticles and an optimal Nafion content

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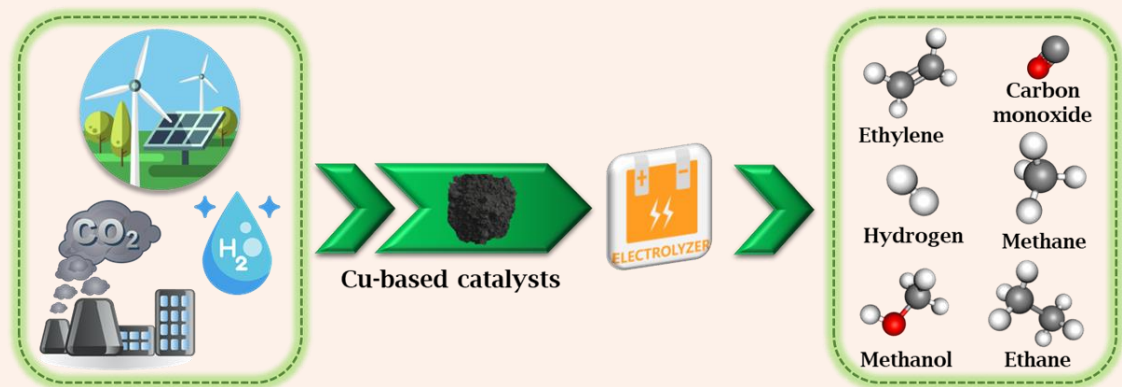
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## OVERVIEW

The electrochemical  $\text{CO}_2$  reduction represents a promising alternative to mitigate  **$\text{CO}_2$  emissions** and combat **climate change**<sup>1</sup>.

In this work, the catalytic ink deposition on a carbon paper support has been carried out both by **airbrushing** (manual) and by **spray-coating** (automated).

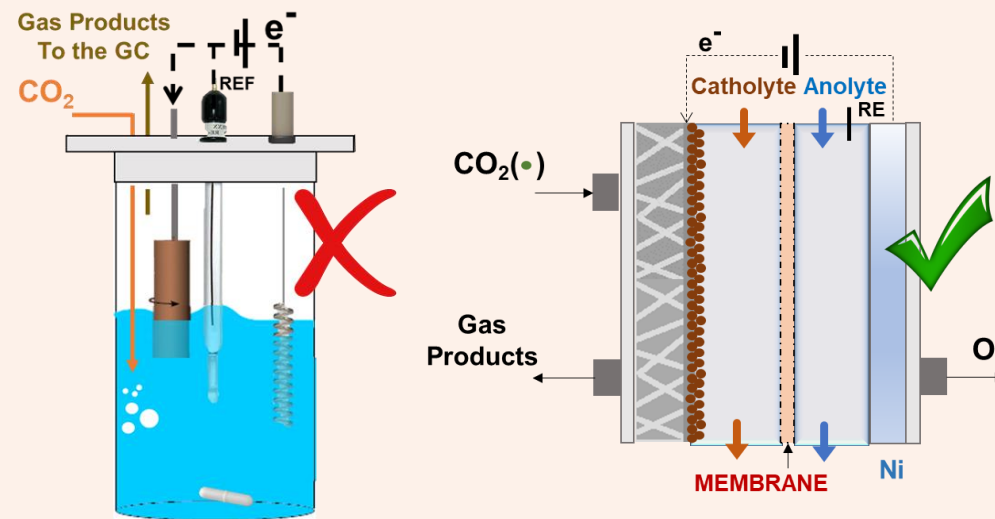


**Cu-based catalysts**<sup>2</sup> have been used to perform the EC- $\text{CO}_2$ RR in a GDE-based setup.

The physical-chemical properties of the catalytic materials employed have been investigated through different characterization techniques.

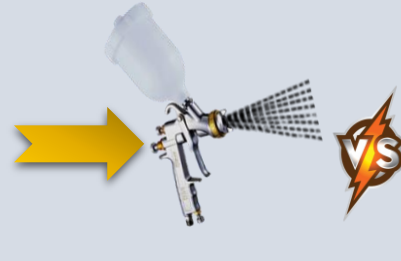
## AIMS

- To overcome the **limitations** shown by configurations with  **$\text{CO}_2$  dissolved** in the electrolyte.
- To **exploit** the potential of **Copper-based** catalysts in **prompting the C-C coupling** and **enhancing alcohols production**.
- To achieve a **more uniform deposition**<sup>3</sup> of the catalyst particles by means of an **automated and scalable technique**.

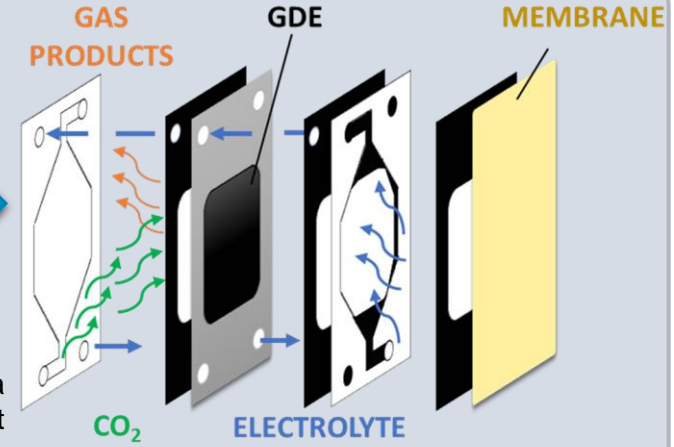
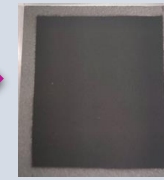


# MATERIALS AND METHODS

Cu-based catalysts have been prepared by co-precipitation method.



GDE active area:  
10 cm<sup>2</sup>



- The catalytic ink consists of: **Cu-based catalyst** nanoparticles, carbon support (Vulcan XC 72R), Nafion dispersion and **isopropyl alcohol**.

- The catalytic ink has been deposited onto a porous and conductive support by **airbrusher/spray coater**.

- Electrochemical measurements in a **continuous flow cell** at ambient conditions.

3-electrode systems

Working Electrode: **Cu-based GDE**  
Reference Electrode: Ag/AgCl  
Counter Electrode: Ir-MMO plate

# OUTCOME OF THE WORK

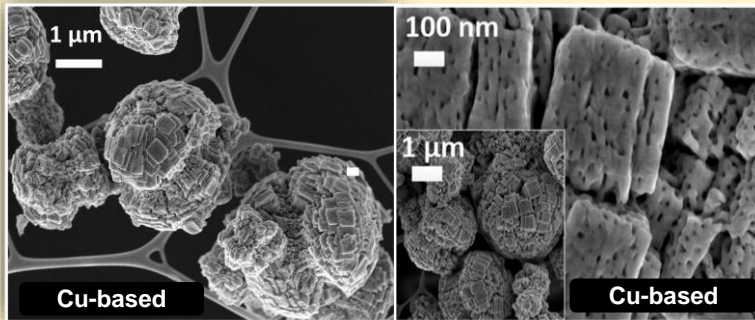


Fig. 1 FESEM micrographs of the synthesized materials.

**Microspherical particles** made up of rectangular section-structures can be observed.

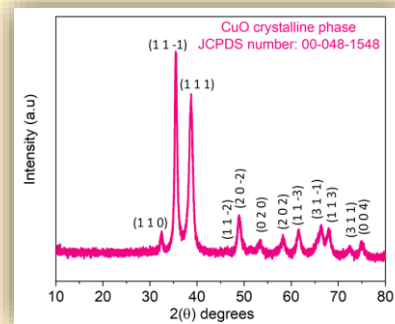


Fig. 2 XRD pattern of the synthesized materials.

The XRD analysis has detected the presence of only CuO in the **crystalline structure**.

Table 1. Physical-chemical properties of the synthesized material.

Catalyst	BET surface area, m <sup>2</sup> g <sup>-1</sup>	Total pore volume, cm <sup>3</sup> g <sup>-1</sup>	Crystallite size, nm (11-1) facet of CuO
Cu-based	<b>23.65</b>	0.131	<b>14</b>

The **Cu-based** catalyst is constituted by **nanocrystals**.

# OUTCOME OF THE WORK

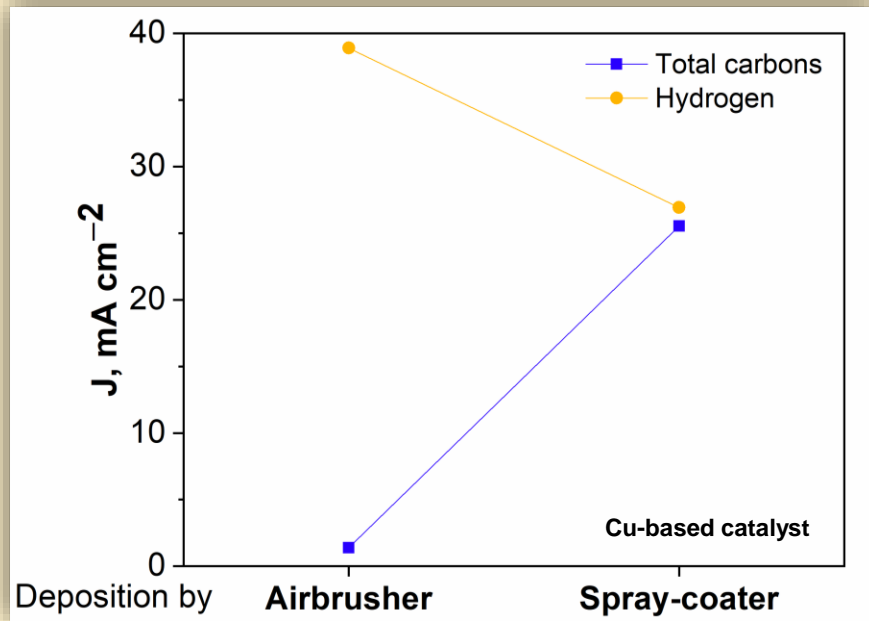


Fig. 3 Effect of the deposition technique on partial current densities (applied current density: 50 mA cm<sup>-2</sup>).

The **spray-coated** electrode far exceeded the performance of the hand-made electrode.

A higher activity (>~10 mA cm<sup>-2</sup>) has been evidenced by the **spray coated-electrode** during linear sweep voltammetry under CO<sub>2</sub> flow.

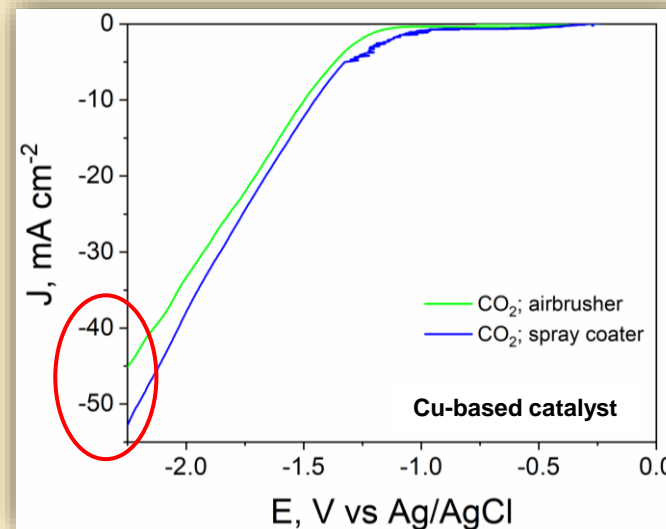


Fig. 4 Linear sweep voltammetry

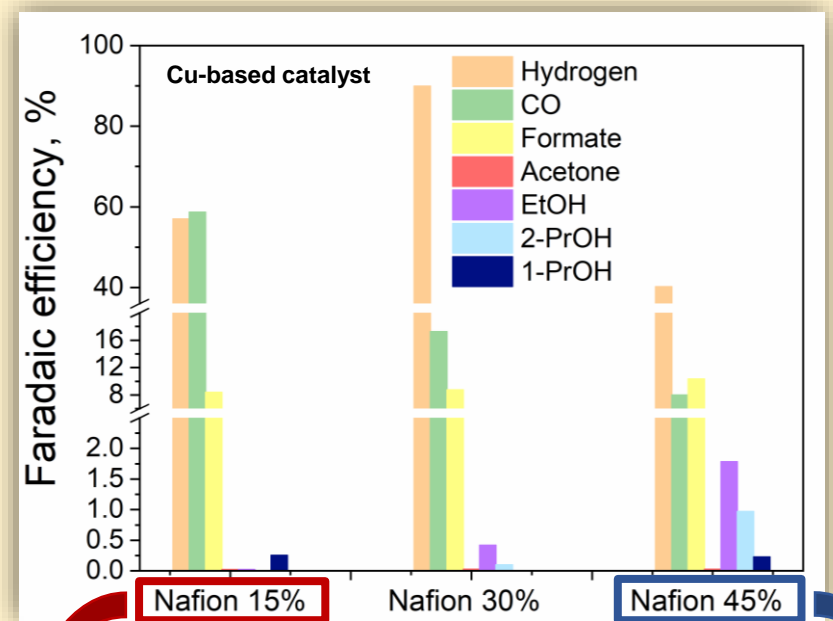


Fig. 5 Faradaic efficiencies of liquid and gas products: Nafion content effect.

A **lower** Nafion content has led to increase CO selectivity; whereas, a **higher** Nafion content has promoted C<sub>1+</sub> production.<sup>4</sup>

## RESEARCH HIGHLIGHTS



The Cu-based catalysts here synthesised by co-precipitation method promoted C<sub>2+</sub> products formation and hampered the hydrogen evolution reaction.



A more uniform and controlled catalyst layer deposition enhanced the electrocatalytic activity.



The spray-coated electrode outperformed the hand-made one, with FE of ~30% towards added-value products.



The Nafion content has a relevant effect in the selectivity of the process.



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## REFERENCES AND ACKNOWLEDGEMENT



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