Department of Chemical Engineering & Chemistry | Inorganic Materials & Catalysis

Impact of hydrophobicity and Bi_2O_3 morphology on gas diffusion electrode stability for electrochemical CO_2 reduction to formate

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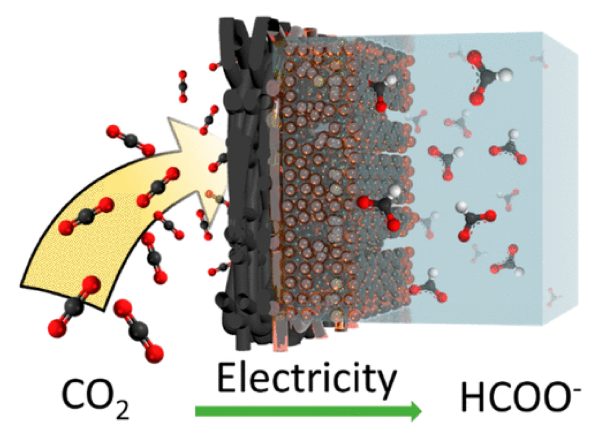
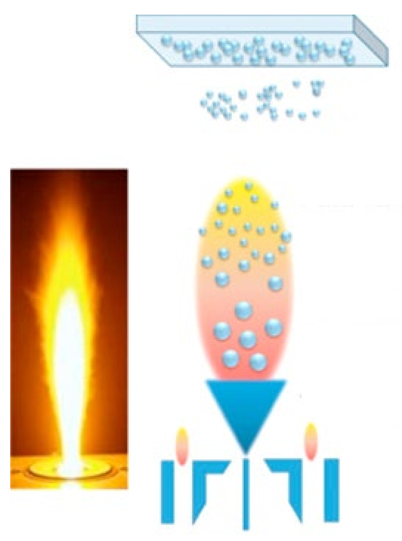
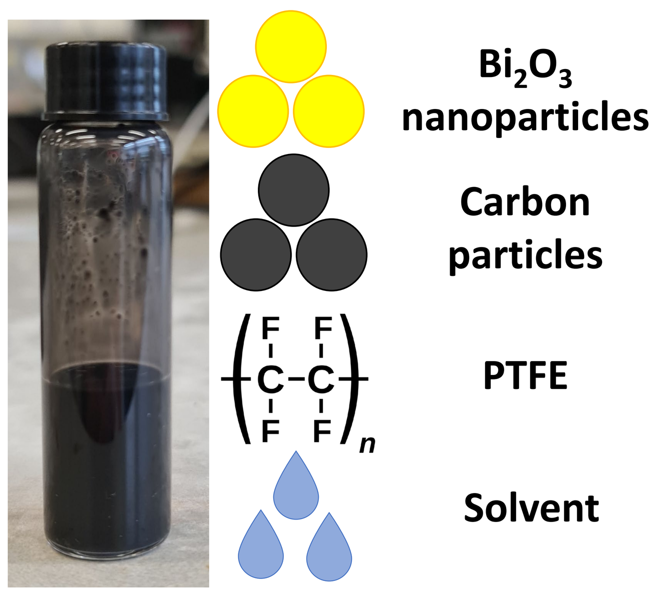
Introduction

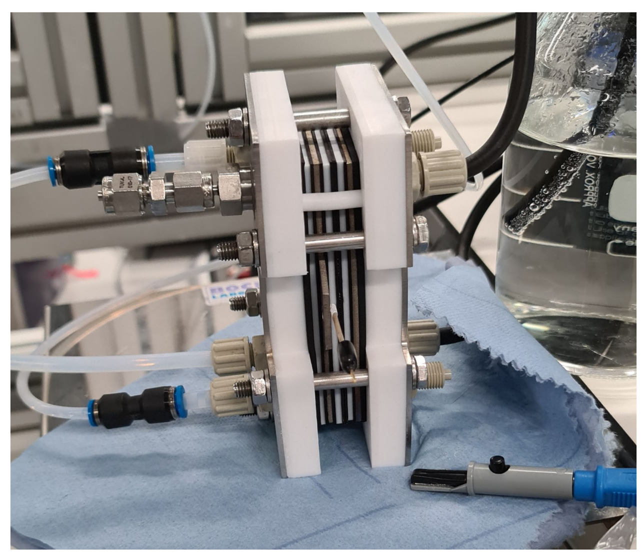
For the electrochemical reduction of CO_2 to formic acid, bismuth oxide (Bi_2O_3) exhibits one of the highest Faradaic efficiencies (FE). To achieve industrially relevant current densities, flow cells are utilized in which a gas diffusion electrode (GDE) is used to eliminate the mass transport limitations. However, the decreasing stability of the electrode due to, for example, flooding of the GDE and catalyst alteration remains one of the challenges to address.[2,3] Herein, we intend to study the the stability and activity of different Bi_2O_3 morphologies. Before studying the catalyst's stability, a stable GDE configuration is developed.



Experimental

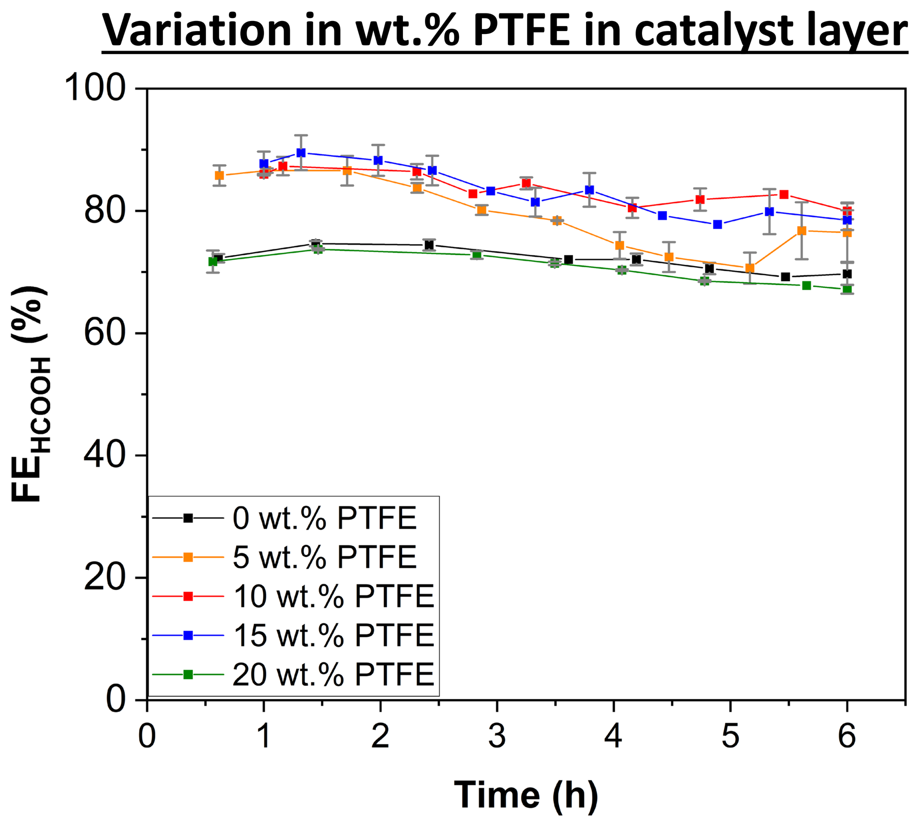




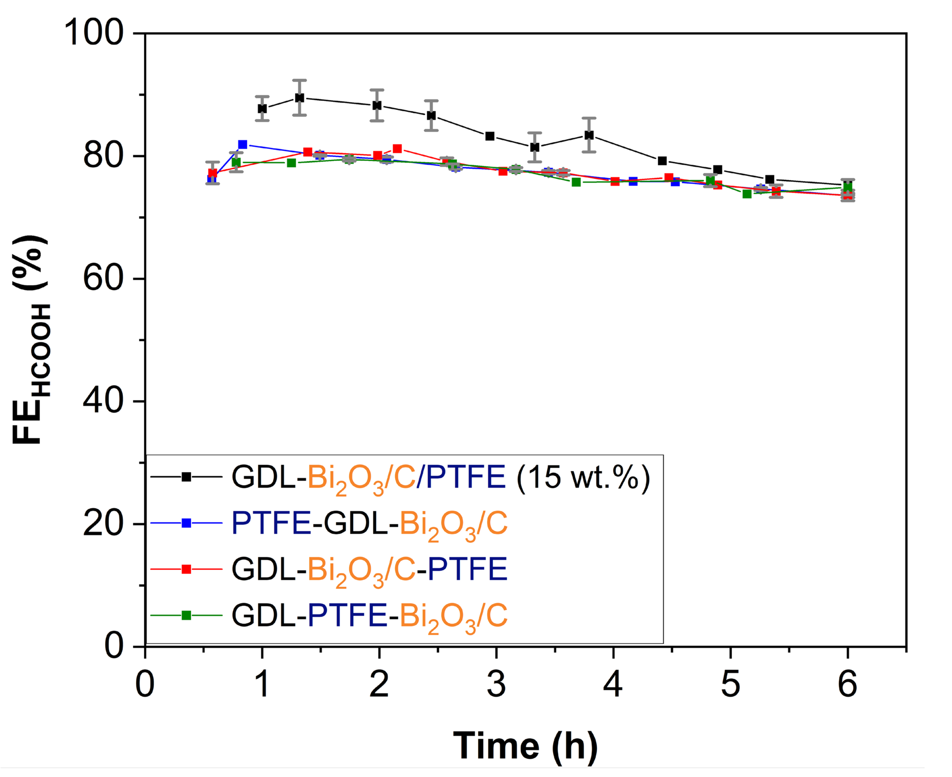


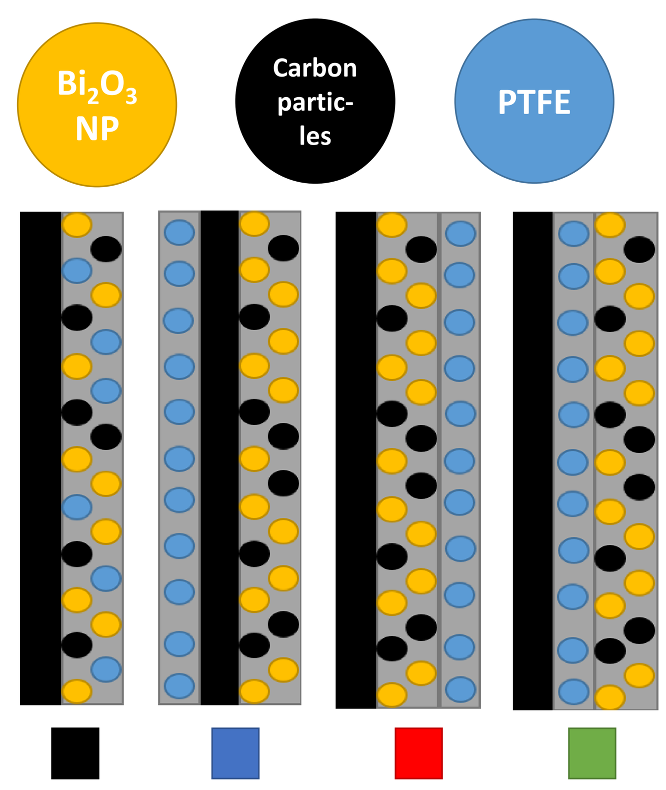
Results

Variation in wt.% PTFE in catalyst layer



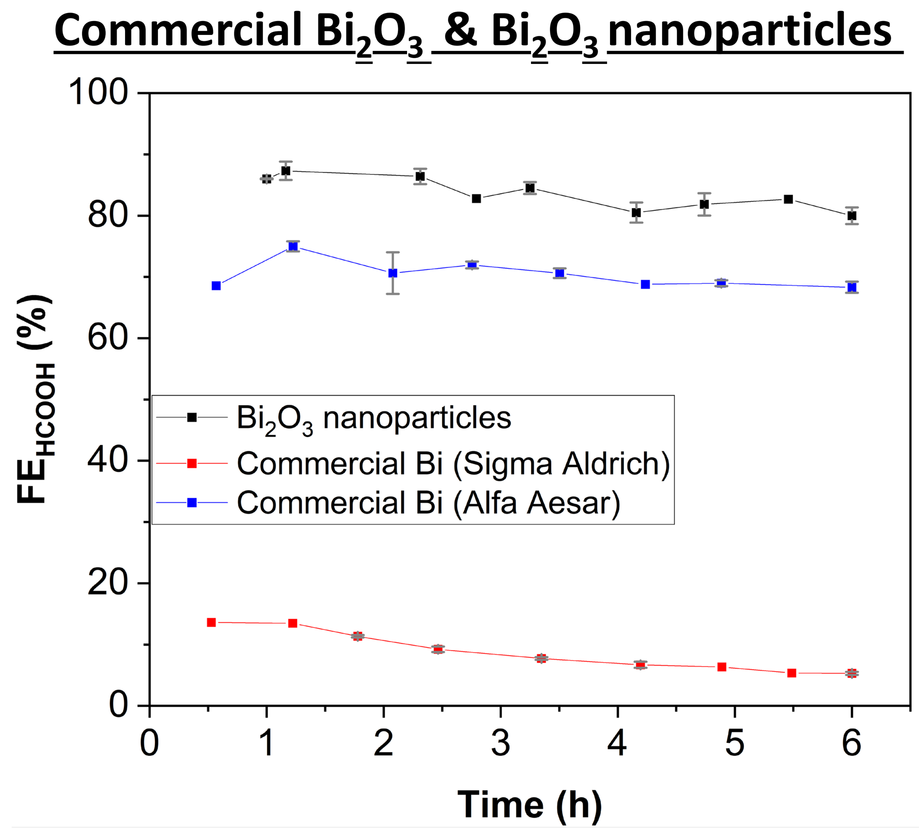
PTFE layer seperate from mixed Bi/C layer

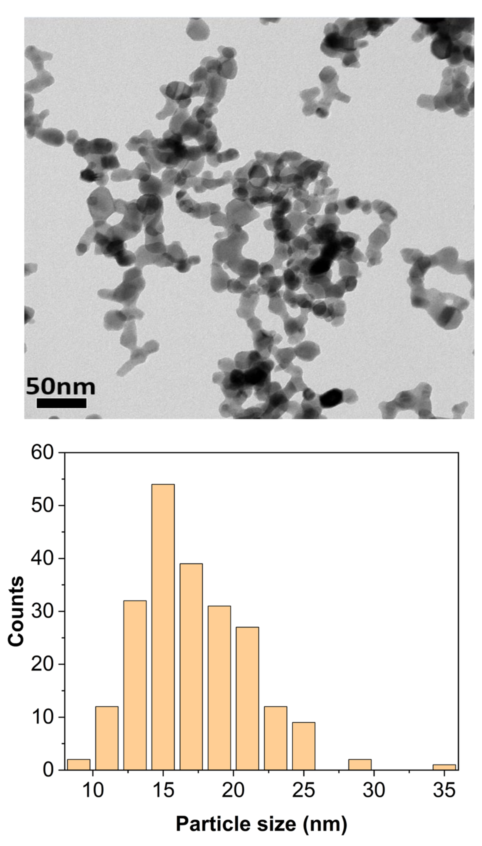


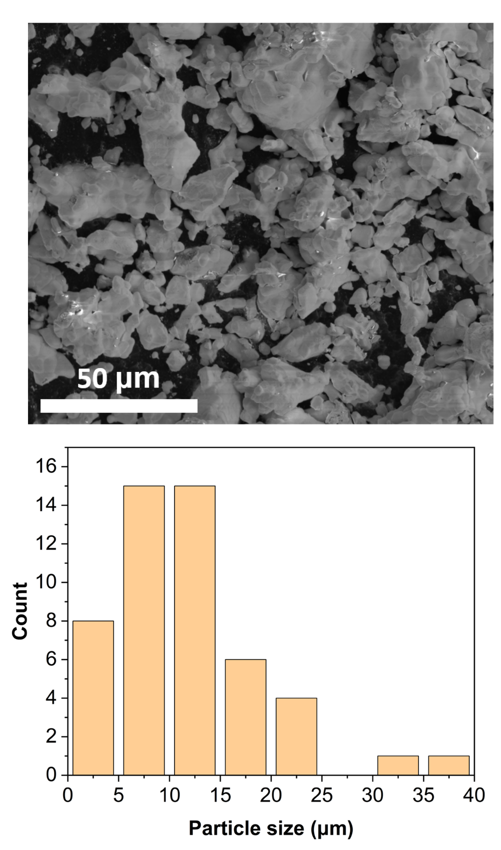


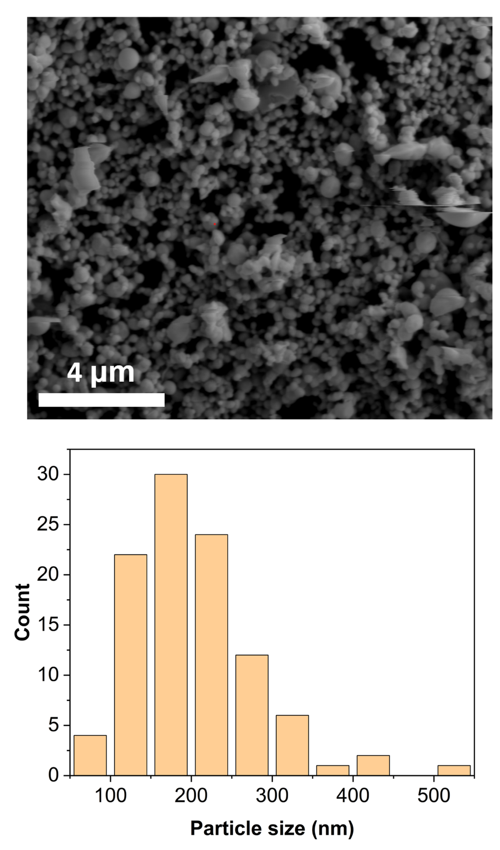
Experimental conditions:
Catholyte:
0.5 M $KHCO_3$ CO_2 saturated
Anolyte:
0.5 M H_2SO_4
Electrolyte and CO_2 flow:
75 ml/min and 10 ml/min
Mode:
chronopotentiometry
Geometric current density:
-200 mA cm^{-2}
Time:
6 hours

Commercial Bi_2O_3 & Bi_2O_3 nanoparticles









Conclusions & Outlook

- Bi_2O_3 nanoparticles, synthesized by FSP, achieve FE > 80% at 200 mA/cm^2
- Addition of PTFE up to 15 wt.% to catalyst layer improves the FE towards formate
- Separately sprayed PTFE layer shows slightly lower FE but better stability over first 6 hours of CO_2 reduction and the position in the GDE does not affect the FE.
- Commercial Bi_2O_3 powder show lower FE compared to FSP synthesized Bi_2O_3 nanoparticles due to surface area effect
- Synthesize different bismuth morphologies for stability tests
- Determine ECSA to understand the intrinsic activity

Acknowledgment

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 838014

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