



HAL
open science

CO₂ Electroreduction efficiency of various Cu based layered double hydroxides

Vanessa Prevot, Ali Tarhini, Mélanie Guyot, Cyrille Costentin,
Chardon-Noblat Sylvie, Mousty Christine

► **To cite this version:**

Vanessa Prevot, Ali Tarhini, Mélanie Guyot, Cyrille Costentin, Chardon-Noblat Sylvie, et al.. CO₂ Electroreduction efficiency of various Cu based layered double hydroxides. Euroclay, Jul 2023, Bari, Italy. hal-04687953

HAL Id: hal-04687953

<https://hal.science/hal-04687953v1>

Submitted on 10 Sep 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

CO₂ Electroreduction efficiency of various Cu based layered double hydroxides.

TARHINI Ali^(a), GUYOT Mélanie^(b), COSTENTIN Cyrille^(b), CHARDON-NOBLAT Sylvie^(b),
MOUSTY Christine^(a), PREVOT Vanessa^{(a)*}

^{a)} Institut de Chimie de Clermont-Ferrand, Clermont-Ferrand (France)

^(b) Département de Chimie Moléculaire, Grenoble (France)

*vanessa.prevot@uca.fr

The emission of CO₂ by industrial action seriously impacts our environment which requires us to consider strategies to reduce the emitted CO₂ to the atmosphere. The electrochemical reduction of CO₂ (CO₂ER) into molecules such as CO, HCOOH, CH₃COOH, and CH₄ is one of the many ways to valorize CO₂ as fuels or chemicals¹. Not only could this help reduce pollution, but it would also convert the CO₂ into valuable products to use as a feedstock. Amongst the different heterogeneous catalysts investigated, Cu based electro-catalysts for CO₂ER ~~Cu electrodes~~ have attracted much attention due to their unique advantages including hydrocarbon production and product selectivity.²

Recently, Cu-based LDH ($[M(II)_{1-x}Al(III)_x(OH)_2]^{x+}[A^{n-}]_{x/n} \cdot yH_2O$, $0.20 \leq x \leq 0.33$), with M(II) = Cu and M(III) = Al have particularly been investigated for CO₂ER. These matrices appear as promising electrocatalyst promoting the electrochemical conversion, in galvanostatic conditions, of CO₂ to CO and HCOOH³. A morphology control allowed to improve the catalytic activity by tailoring the structure of active sites and increasing the surface area/number of active sites.⁴

Herein, the electrochemical efficiencies towards CO₂ER of a series of CuAl-LDH matrices were compared. The LDH materials were synthesized by both the coprecipitation and the polyol method and characterized using powder X-ray diffraction (PXRD), Infrared spectroscopy (FT-IR) and scanning electron microscopy (SEM). Electrochemical characterization of the Cu-LDH modified electrodes was carried out following a specific protocol by linear sweep voltammetry and cyclic voltammetry showing that an electrochemical activation of the Cu-LDH occurred at $E^{app} > -1.4$ V, leading to an enhancement of the electrochemical signal of the copper redox couples, addressing to more accessible catalytic sites and to an increase in current under CO₂ and hence CO₂ activation. The influence of the LDH composition that is the Cu amount into the layer, the presence of Mg or Zn in a ternary layer composition, and the nature of the interlayer anions were investigated showing that the composition Cu_{1.5}Mg_{0.5}Al-CO₃ provides the highest faradaic yield of HCOOH formation, reaching 57%.

- 1- Zhu, D. D.; Liu, J. L.; Qiao, S. Z. Recent Advances in Inorganic Heterogeneous Electrocatalysts for Reduction of Carbon Dioxide. *Advanced Materials* **2016**, 28 (18), 3423.
- 2- Zhao, J.; Xue, S.; Barber, J.; Zhou, Y.; Meng, J.; Ke, X. An overview of Cu-based heterogeneous electrocatalysts for CO₂ reduction. *Journal of Materials Chemistry A* 2020, 8 (9), 4700
- 3- Altaf, N.; Liang, S.; Huang, L.; Wang, Q. Electro-derived Cu-Cu₂O nanocluster from LDH for stable and selective C₂ hydrocarbons production from CO₂ electrochemical reduction. *Journal of Energy Chemistry* 2020, 48, 169.
- 4- Iwase, K.; Hirano, T.; Honma, I. Copper Aluminum Layered Double Hydroxides with Different Compositions and Morphologies as Electrocatalysts for the Carbon Dioxide Reduction Reaction. *ChemSusChem* 2022, 15 (2), e202102340