



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA

ORGANIZZATO DA



Bologna: un hub di ricerca per lo sviluppo  
dell'idrogeno - 9 ottobre 2024

# From waste to useful resources: Metal Organic Frameworks for CO<sub>2</sub> conversion

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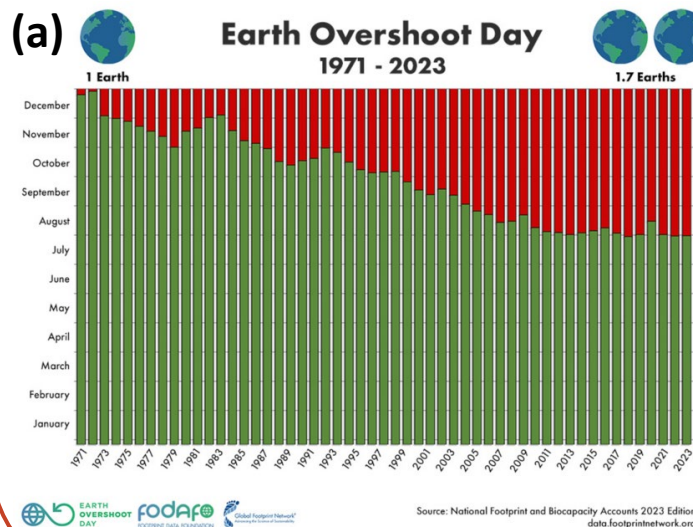
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# Anthropocene and the problem of CO<sub>2</sub>

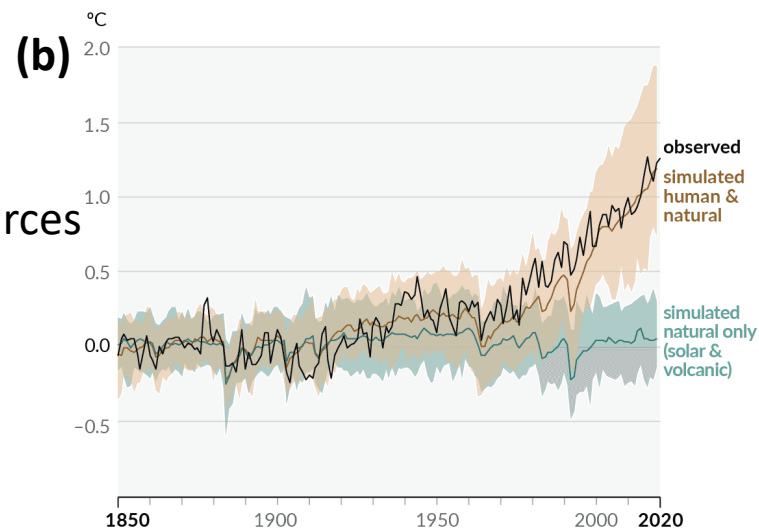
- CO<sub>2</sub> is the main **Green House Gase** (GHGs) in the atmosphere.



## URGENCY

(a) Scarcity of resources

(b) Climate change



HUMANS

ENVIRONMENT

HEALTH

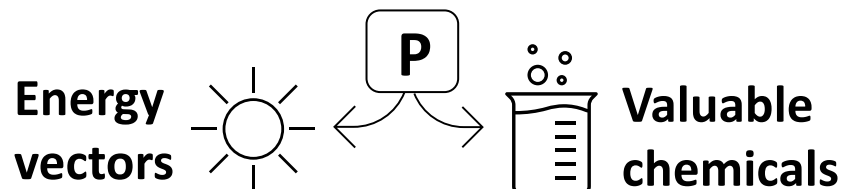
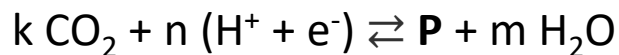


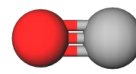
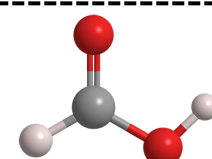
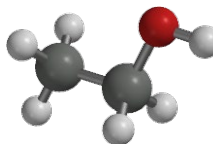
**Systems for  
Energy  
Conversion**

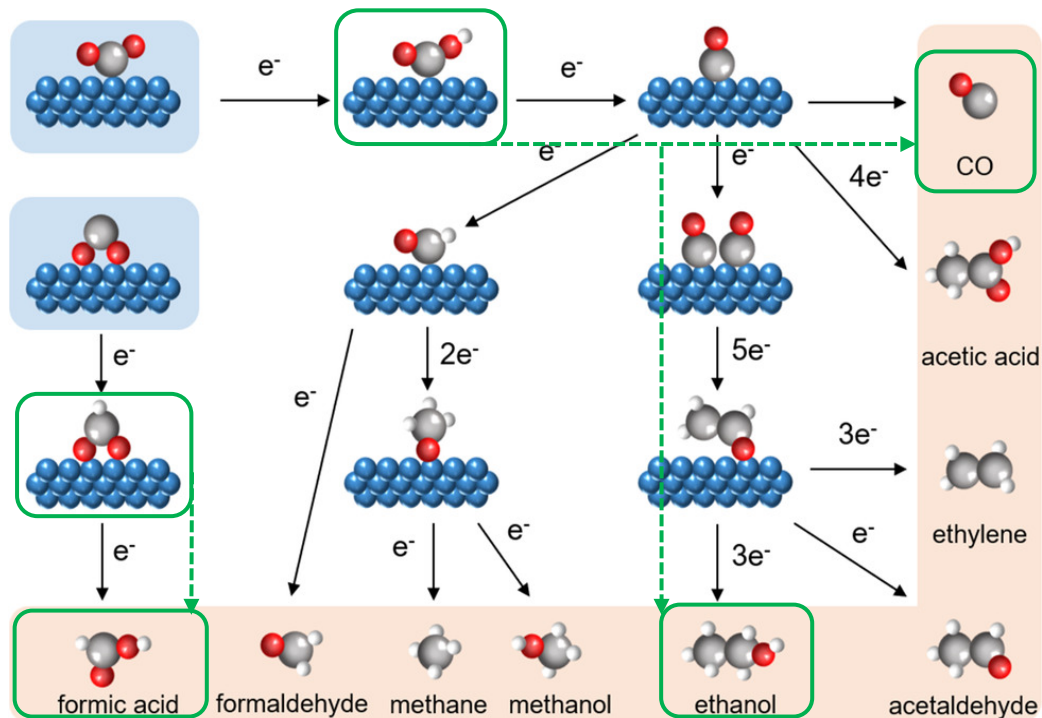
CO<sub>2</sub>RR

# Electrochemical CO<sub>2</sub> Reduction Reaction (CO<sub>2</sub>RR): problems and products

## Proton Coupled Electron Transfer (PCET)



-  **CO** to produce **syngas**
-  **HCOOH** to produce H<sub>2</sub> if dehydrogenated
-  **CH<sub>3</sub>CH<sub>2</sub>OH** used in fuel cell to get H<sub>2</sub> or as bioethanol



Joule 3, 257–264, January 16, 2019, 2018 Elsevier Inc.,  
 ChemSusChem 11.18 (2018), pp. 3092–3095,  
 Electrochemistry Communications, Volume 148, 2023, 107452

# Metal Organic Frameworks (MOFs) as molecular catalysts

**Metal Organic Frameworks (MOFs)** as molecular materials results to be promising electrocatalysts thanks to their structure. Metal ions and organic ligands are able to self-assemble generating a periodic structure and uniform dispersion of catalytically active sites.

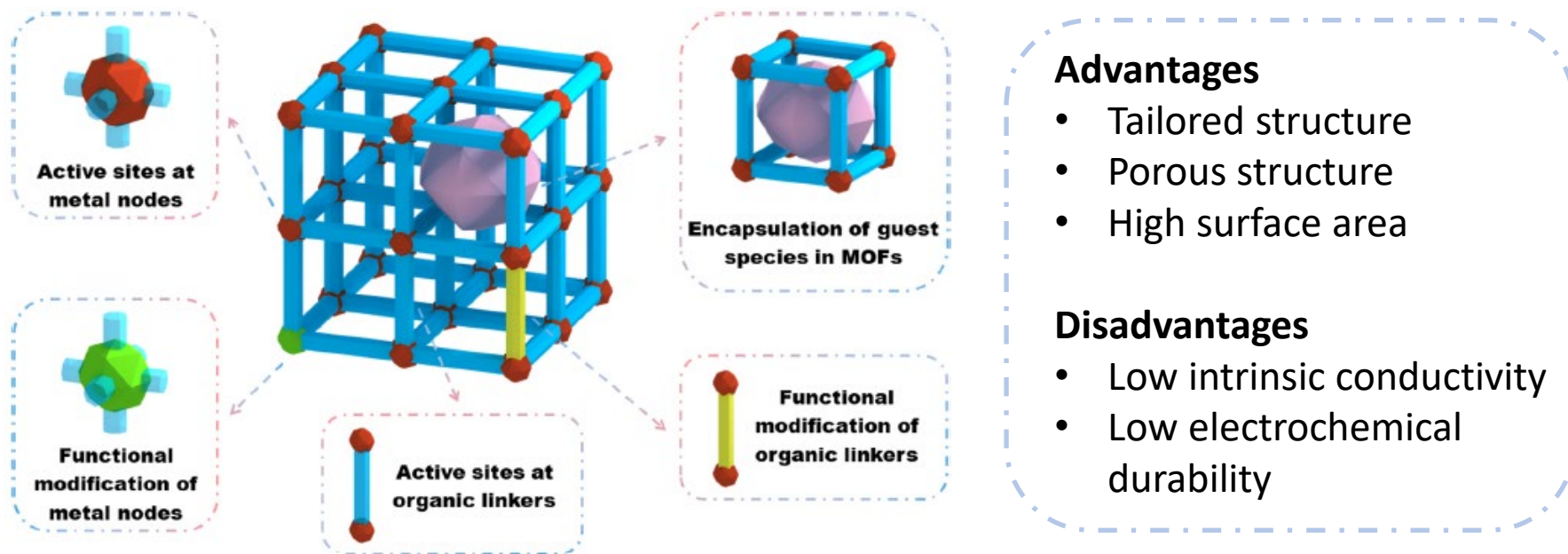


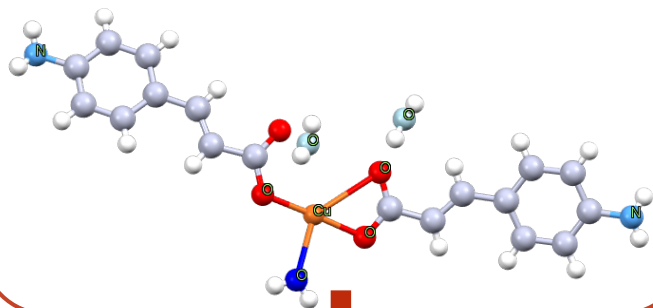
Figure. Schematic illustration of the typical structure of MOFs

ACS Materials Letters 2022 4 (11), 2058-2079

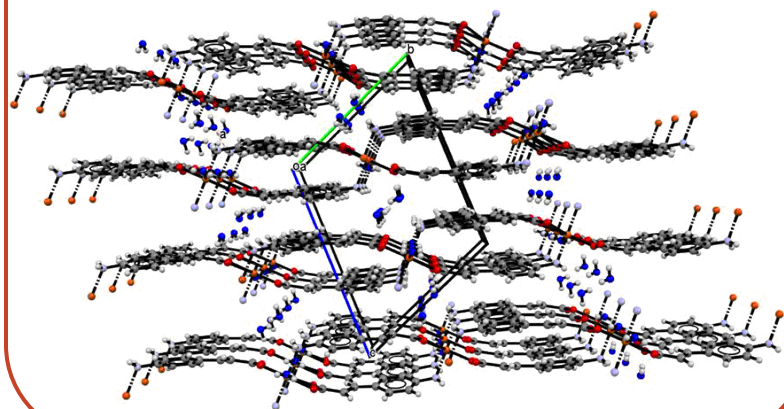
# Cu-4AC: why and how?

## 1. CATALYST

Copper ( $\text{Cu}^{2+}$ ) as metal centre

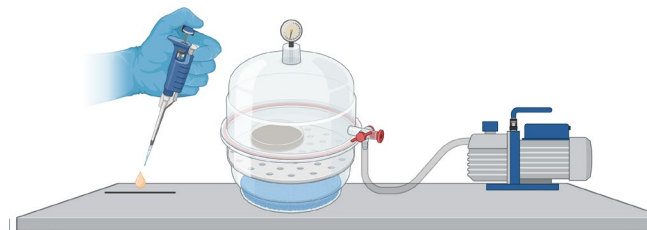


To achieve the structure

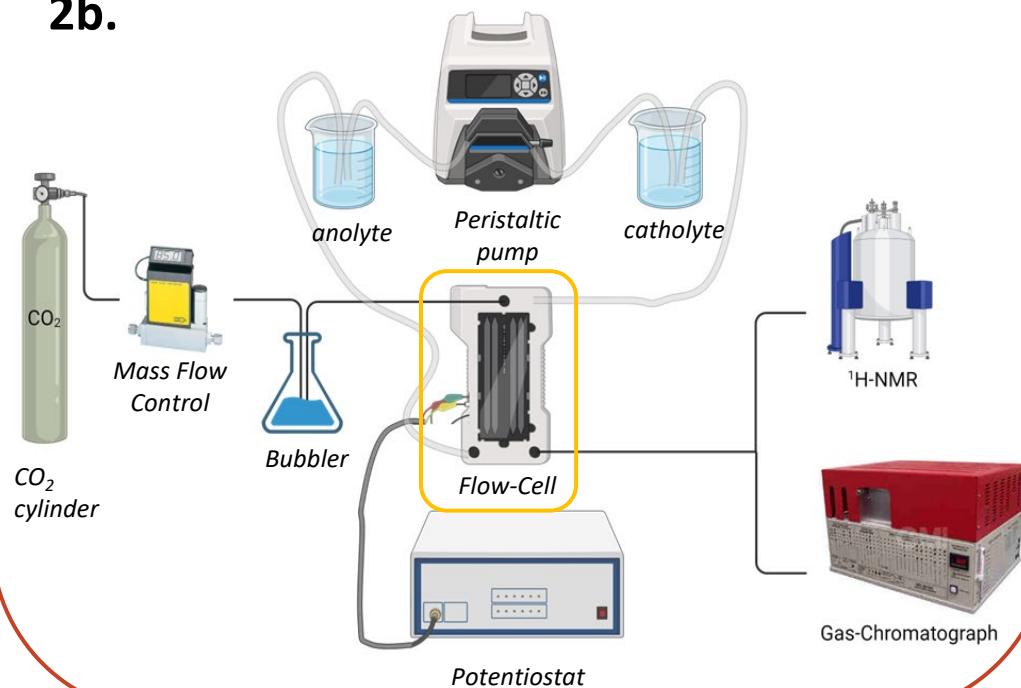


## 2. SET-UP

2a.



2b.



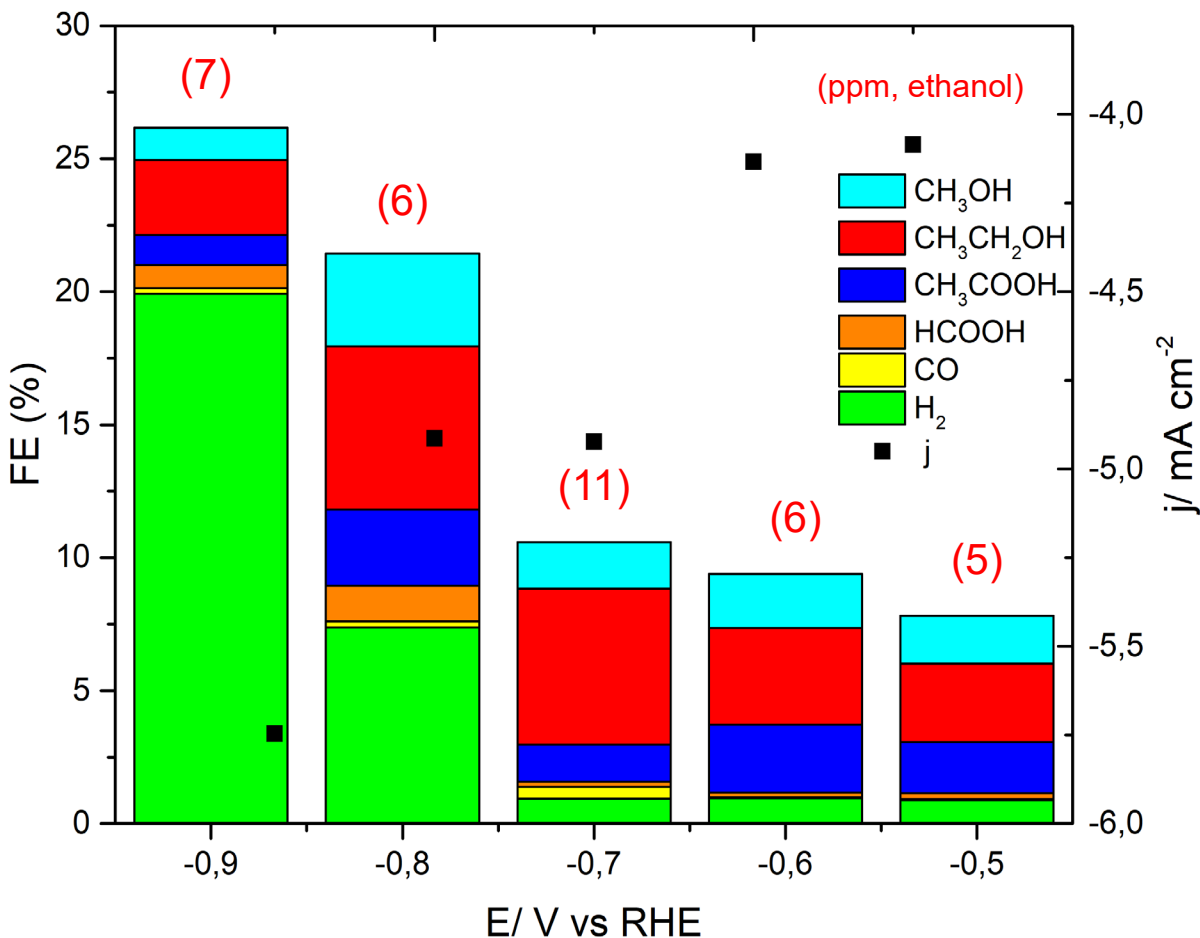
ACS Catalysis 11.12 (2021), pp. 7350–7357

ACS Energy Lett. 2023, 8, 4156–4161

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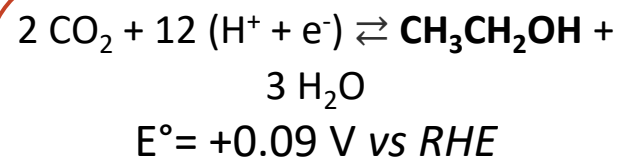


# Cu-4AC: CO<sub>2</sub>RR evaluation of performances



## Experimental parameters:

- Catalyst loading:  
505  $\mu\text{g} \cdot \text{cm}^{-2}$
- Electrolyte:  
KHCO<sub>3</sub> 0.5 M
- Liquid Flow rate:  
6 mL  $\cdot$  min<sup>-1</sup>
- Gas Flow Rate:  
5 cm<sup>3</sup>  $\cdot$  min<sup>-1</sup> (sccm)



## CH<sub>3</sub>CH<sub>2</sub>OH to H<sub>2</sub>:

- Steam-reforming (SR)
- Partial oxidation (POX)
- Oxidative Steam Reforming (OSR)



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Credits:

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