Workshop "Innovative technologies for sustainable management of urban and industrial waste streams"

SYN-GAS PRODUCTION FROM ELECTROCHEMICAL REDUCTION OF CO_2

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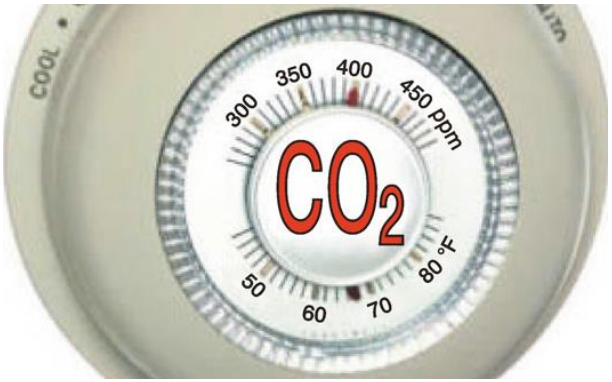
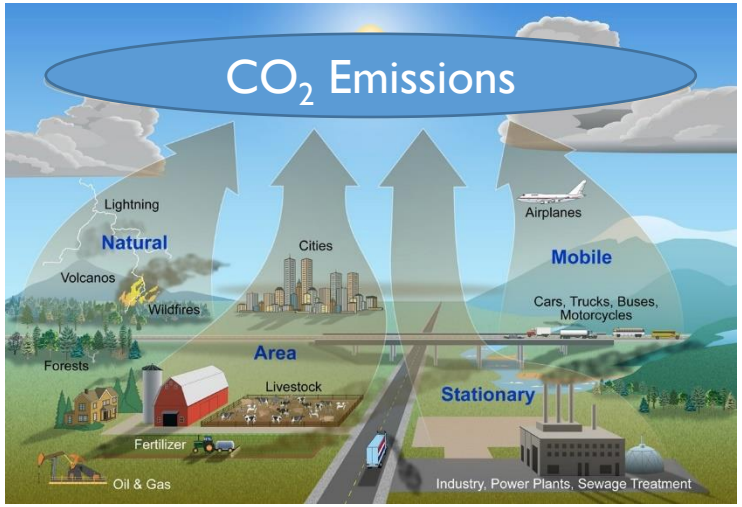
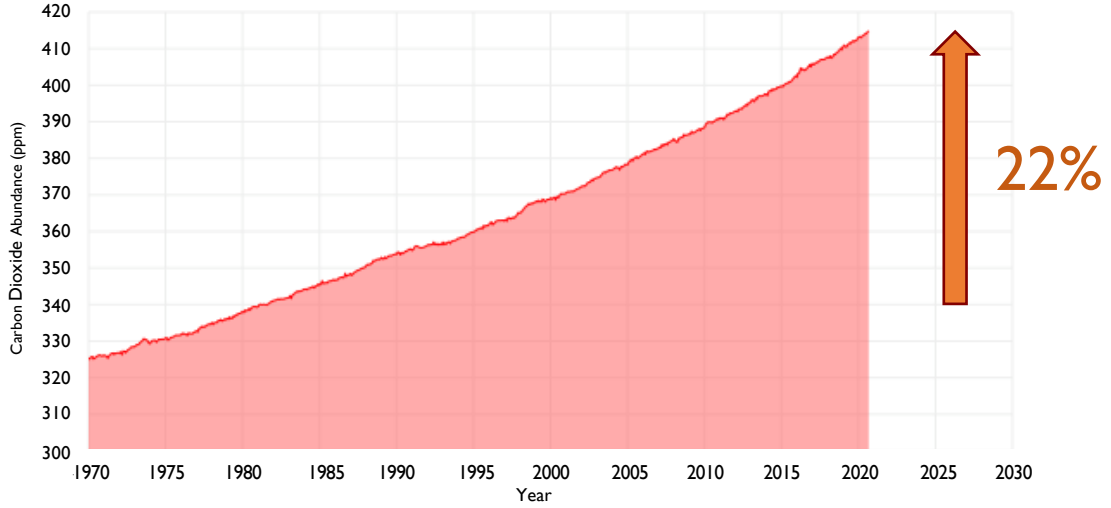
Carbon Dioxide

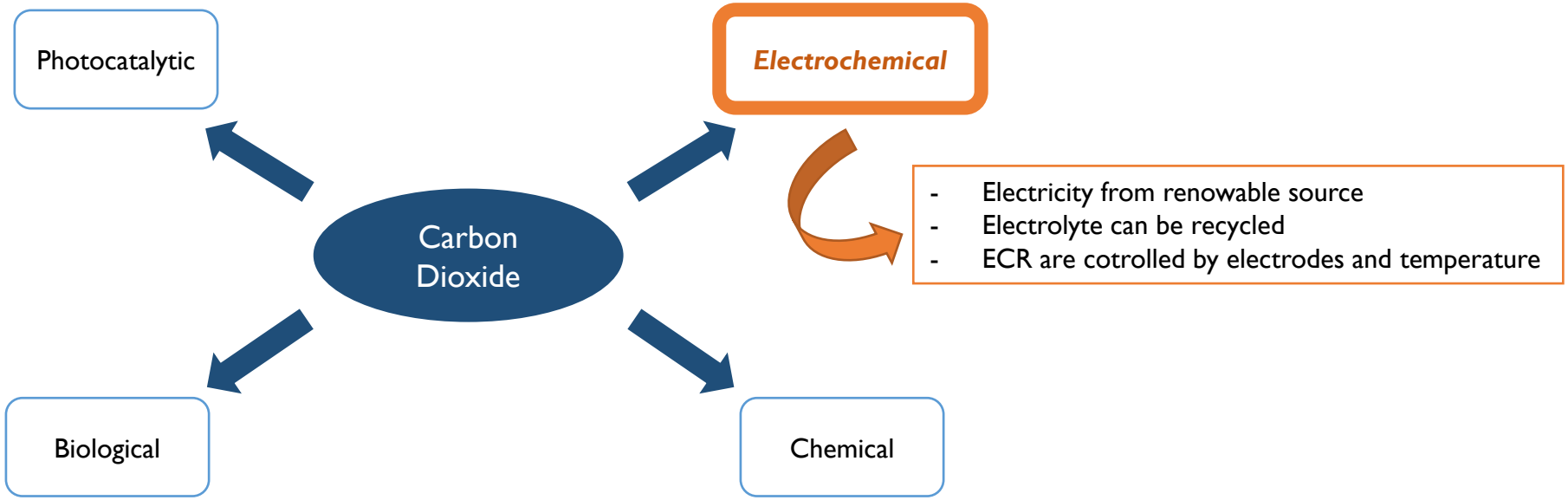






Source: https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide

Transformation ways

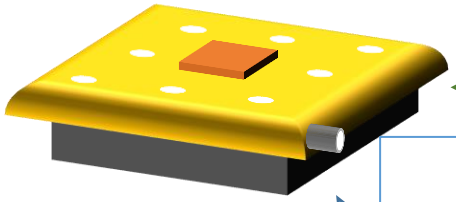


Catalyst

Experimental Scheme: Liquid phase

$CO_2 + 2H^+ + 2e^- \rightarrow CO + H_2O$

$2H^+ + 2e^- \rightarrow H_2$



Peristaltic Pump 5mL/min

Syn-Gas (CO, H_2)

AgNPs or CuNps on GDL

$CO_2 + xH^+ + xe^-$

Nafion 117 Membrane

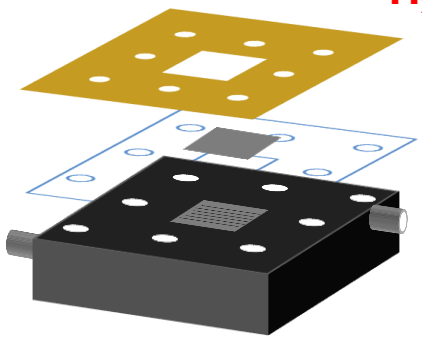
$O_2 + 4H^+ + 4e^-$

Ni Foam

H_2O

$KHCO_3$ 0,5M + EDTA 0,02M

Peristaltic Pump 5mL/min



$KHCO_3$ 0,5M + EDTA 0,02M

Mass Flow 100mL/min

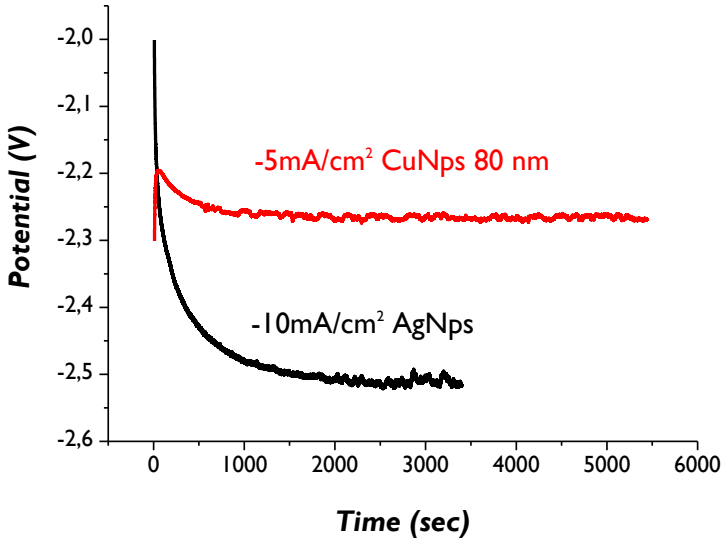
CO_2 Gas

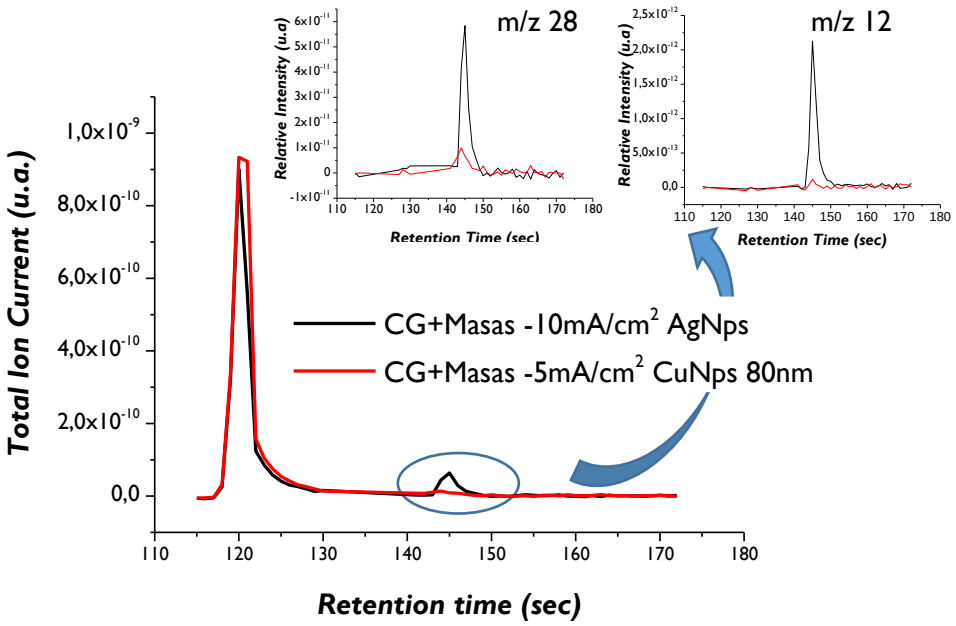
Previously we work:

- Copper foil and Silver thread in three electrode cell
- Raman such as Products Analyzer in three electrode cell

Gas Chromatograph

Mass Spectrometer



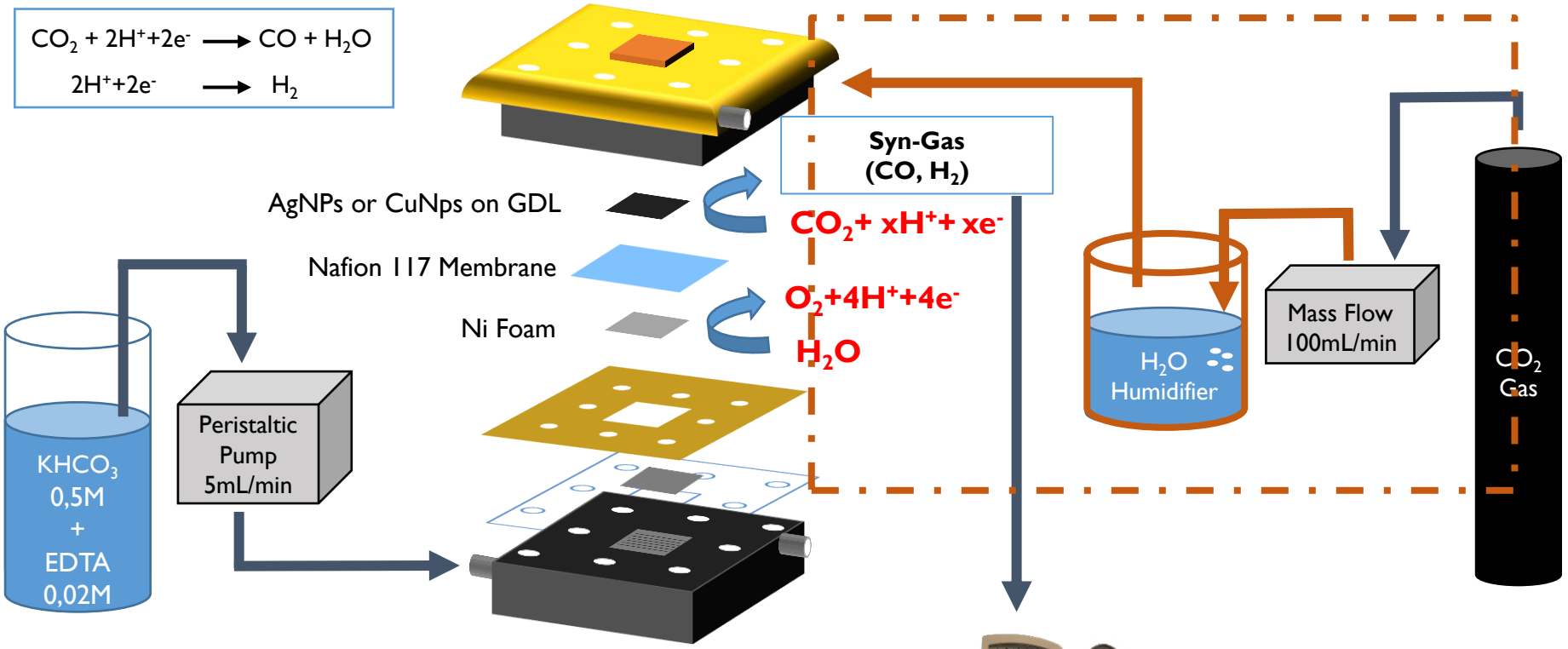


Catalyst 1mg/cm²	[KHCO₃] (M)	Supported on Carbon	Current density applied on ECR (mA/cm²)	Potential (V)	Rate CO (ppm/min)	Rate H₂ (ppm/min)	CO : H₂
AgNps 100nm	0.5	No	-5	-2.29	<DL	949	-
			-10	-2.50	99	1331	0.07
			-25	-3.05	<DL	2654	-
AgNps 100nm	3	No	-25	-2.77	181	3712	0.05
			-50	-3.10	124	6222	0.02
			-100	-3.42	55	11104	0.005
CuNps 80nm	0.5	No	-5	-2.27	6	1045	0.01
			-10	-2.55	-	2019	-
			-25	-2.95	-	2551	-
CuNps 22nm	0.5	Yes	-10	-3.12	-	889	-
			-25	-3.18	-	1810	-

Experimental Scheme: Gas phase

$CO_2 + 2H^+ + 2e^- \rightarrow CO + H_2O$

$2H^+ + 2e^- \rightarrow H_2$

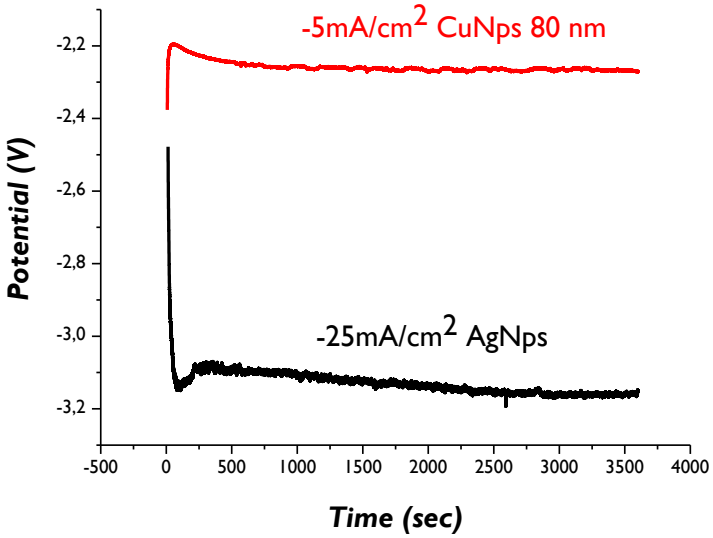


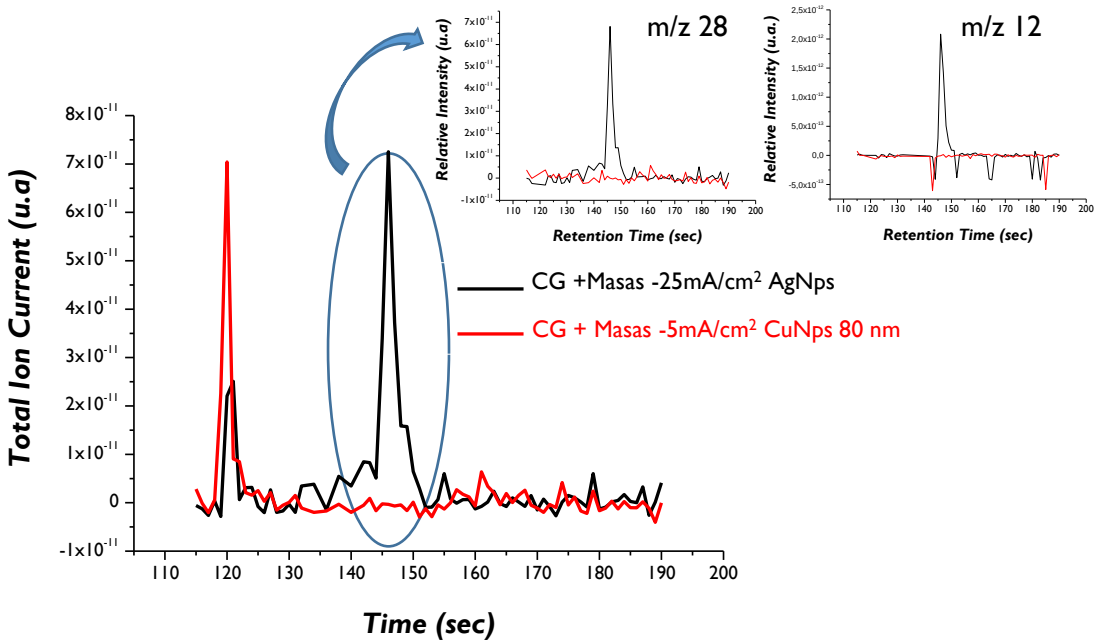
Previously we work:

- Pt and IrO_2 such as anode
- Synthetized Copper and Silver Nanoparticles
- Controlled Conditions: Temperature and Pressure

Gas Chromatograph

Mass Spectrometer





Catalyst 1mg/cm²	CO_2 Flow (mL/min)	Degree of wetting	Supported on Carbon	Current density applied on ECR (mA/cm²)	Potential (V)	Rate CO (ppm/min)	Rate H_2 (ppm/min)	CO:H_2
AgNps 100nm	100	Low	No	-5	-2.34	132	644	0.20
				-10	-2.58	310	573	0.54
				-25	-3.12	1782	815	2.19
AgNps 100nm	100	High	No	-10	-2.15	-	1430	-
				-25	-2.64	336	2102	0.16
CuNps 80nm	100	Low	No	-1	-1.75	-	571	-
				-5	-2.66	-	1275	-
CuNps 22nm	100	Low	Yes	-5	-2.68	-	941	-
				-10	-3.07	-	1598	-

Experimental Results: Liquid phase

Catalyst 1mg/cm^2	[KHCO3] (M)	Supported on Carbon	Current density applied on ECR (mA/cm^2)	Potential (V)	Rate CO (ppm/min)	Rate H_2 (ppm/min)	CO : H_2
AgNps 100nm	0.5	No	-5	-2.29	<DL	949	-
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CuNps 22nm	0.5	Yes	-10	-3.12	-	889	-
			-25	-3.18	-	1810	-

Experimental Results: Gas phase

Syn-Gas (CO:H_2) → >1

Catalyst 1mg/cm^2	CO_2 Flow (mL/min)	Degree of wetting	Supported on Carbon	Current density applied on ECR (mA/cm^2)	Potential (V)	Rate CO (ppm/min)	Rate H_2 (ppm/min)	CO:H_2
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Two CO_2 electroreduction methods have been developed in presence of silver and copper nanoparticles catalysts. The first one in liquid phase and the second in gas phase.

The silver catalyst is more efficient for syn-gas production than copper catalyst.

One of the objectives is to achieve a high CO: H_2 ratio. In this way, ECR in the gas phase seems more efficient than the liquid phase.

Liquid phase

Eliminate impurities on copper (EDTA is not a good method).

Gas phase

Work under: controlled pressure and temperature

Improvements in both methods

- Use other catalysts such as bimetallic Sn-Cu
- Apply different current density
- Study the influence of the amount of catalyst
- Formation of C1-C2 Hydrocarbons with copper catalyst

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