Plasma catalysis in liquid water for CO_2 conversion

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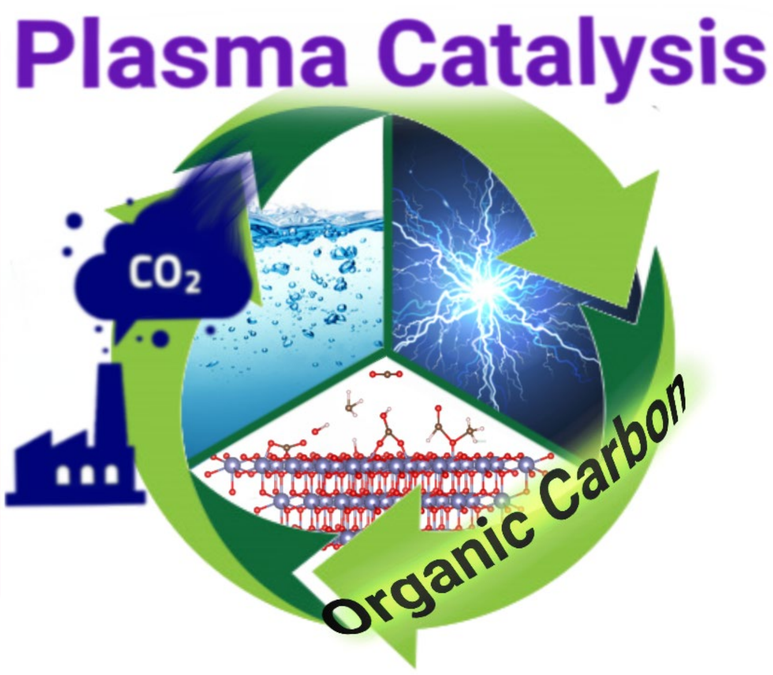
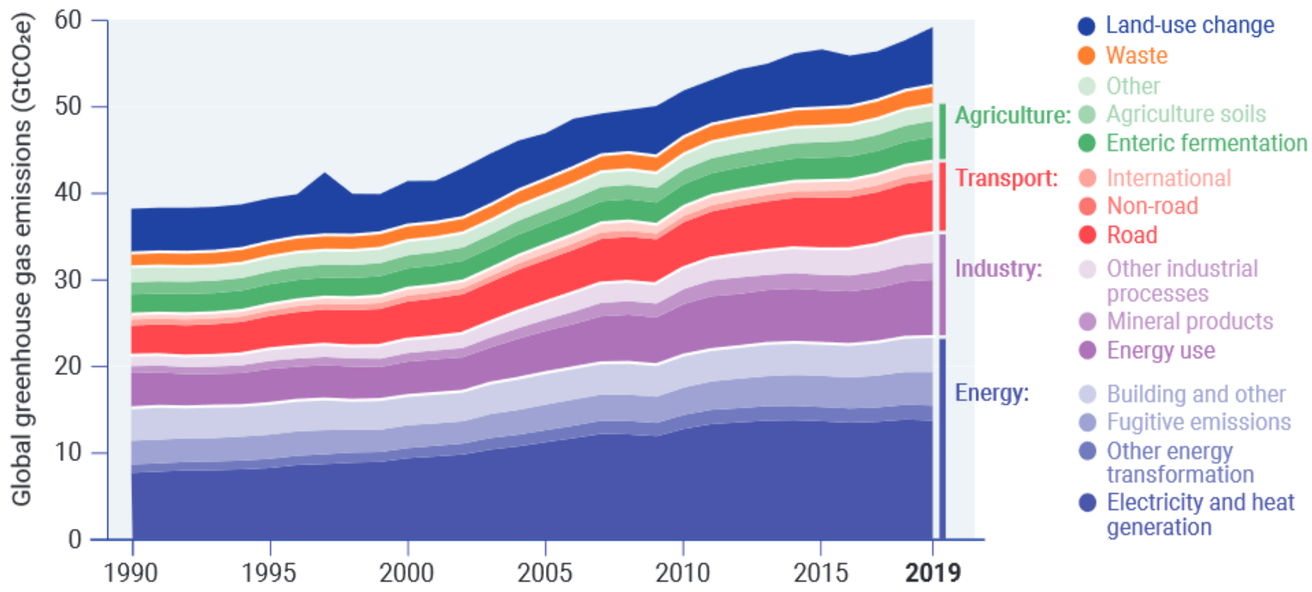


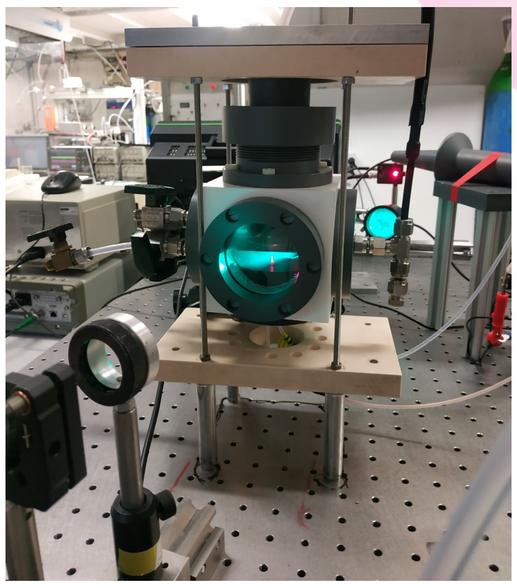
GHG emissions at the sectoral level.

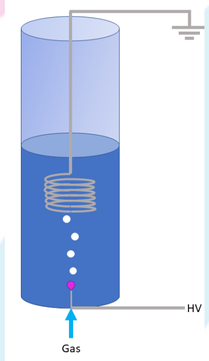


Source: Crippa *et al.* (2020)

United Nations Environment Programme (2020). *Emissions Gap Report 2020*. Nairobi

Non-thermal Liquid phase plasma-catalytic reactor

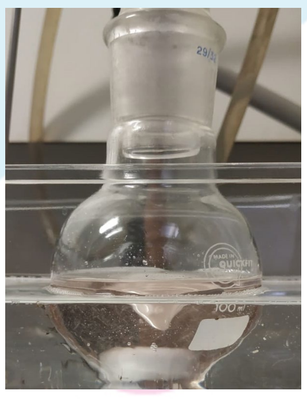




- Catalyst suspended in the liquid
- 20 kV, 300 Hz, bubbling CO2
- Laser triggering power supply
- High speed camera

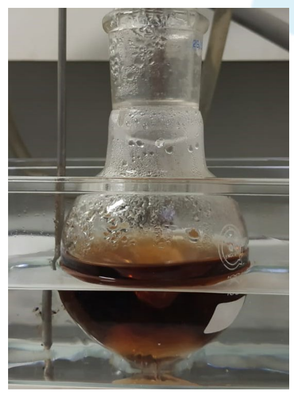
Synthesis

Glycerol + $Mn(NO_3)_2$



180° C

Manganese(II) Glycerolate

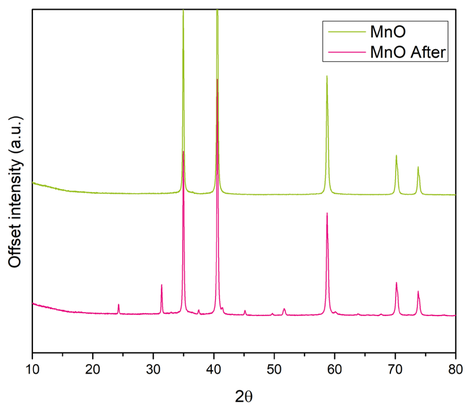


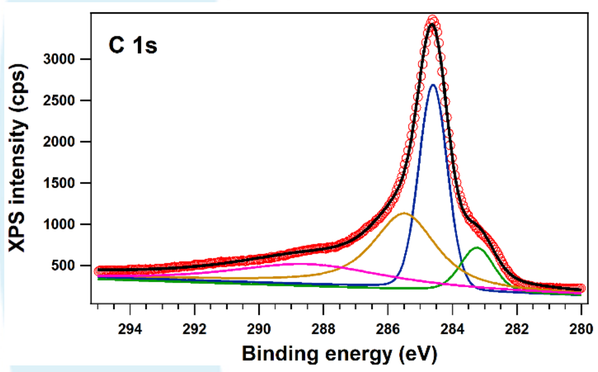
- N_2 / 850° C → MnO
- Air / 750° C → Mn_2O_3
- Air / 1100° C → Mn_3O_4

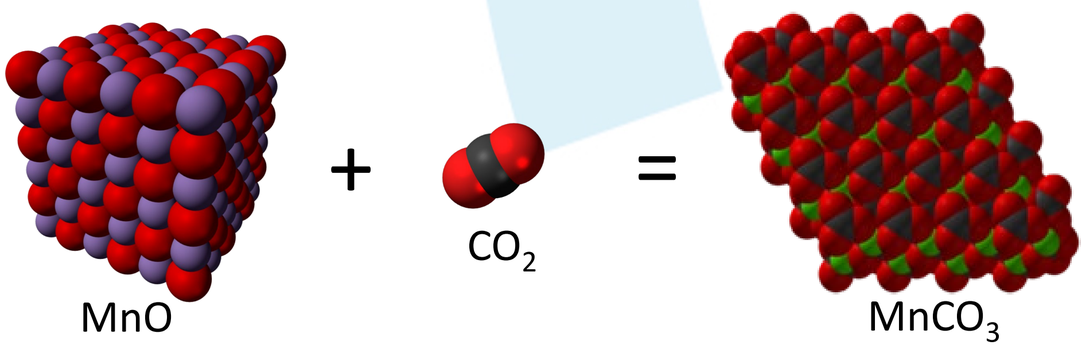
- Green synthesis of MnO, Mn_2O_3 and Mn_3O_4
- Different oxidation states allow to investigate catalyst effect and stability.

- Catalyst characterization by XRD and XPS.
- Products analyzed by TOF-MS, TOC and FTIR

Plasma liquid: new route for CO_2 fixation into solids?

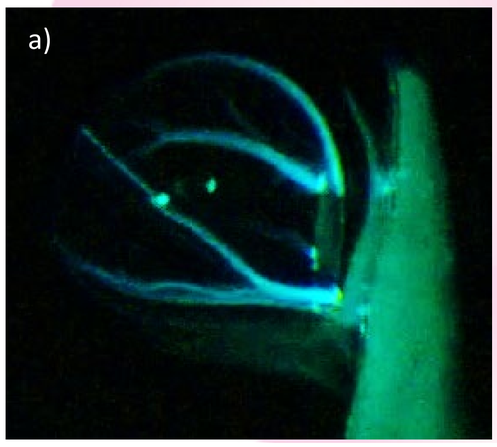


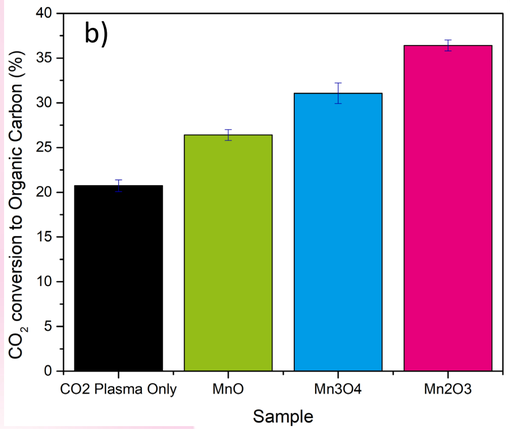


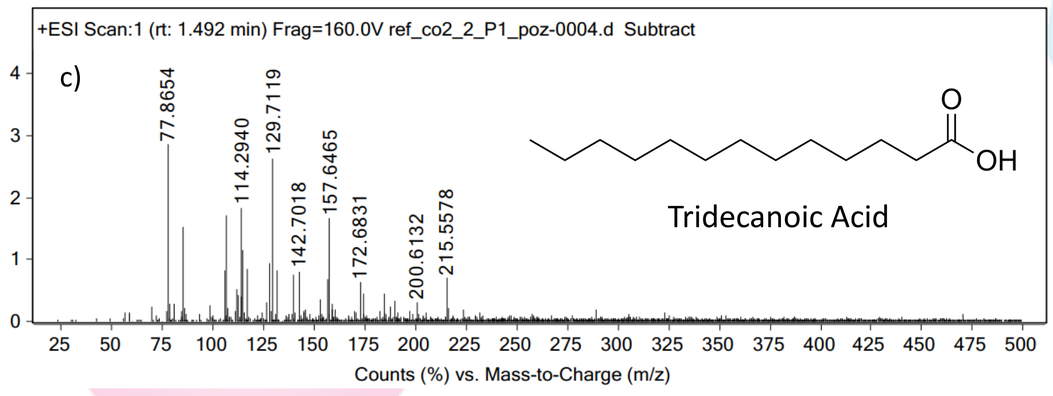


a) XRD MnO before and after plasma reactions. b) XPS MnO after reactions.

And organic liquids too?







a) Plasma filaments inside CO_2 bubbles. b) Total organic carbon, liquid samples after 15 min of reaction. c) TOF-MS sample CO_2 plasma alone.

- XRD shows the presence of peaks of $MnCO_3$ after the discharge.
- XPS shows band associated with carbonates.
- MnO did not perform well as a catalyst but it was successfully converted to $MnCO_3$.
- Fixating CO_2 into solids is also a topic of great research interest and there are still no reports of it being done using plasma and liquid water.

- Using liquid water in contact with CO_2 plasma unlocks reaction paths that lead to the formation of long-chain organic acids.
- More stable catalysts (Mn_2O_3 and Mn_3O_4) performed significantly better than plasma alone.
- Such large molecules can be used to store carbon efficiently, since liquids are more easily stored and transported.
- Being performed in liquid-phase, it can be coupled with other conventional techniques (photo and electrocatalysis), using the same catalysts.

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