Carbon dioxide on CQE@Técnico research:

From separation to capture and conversion into greener fuels and chemicals

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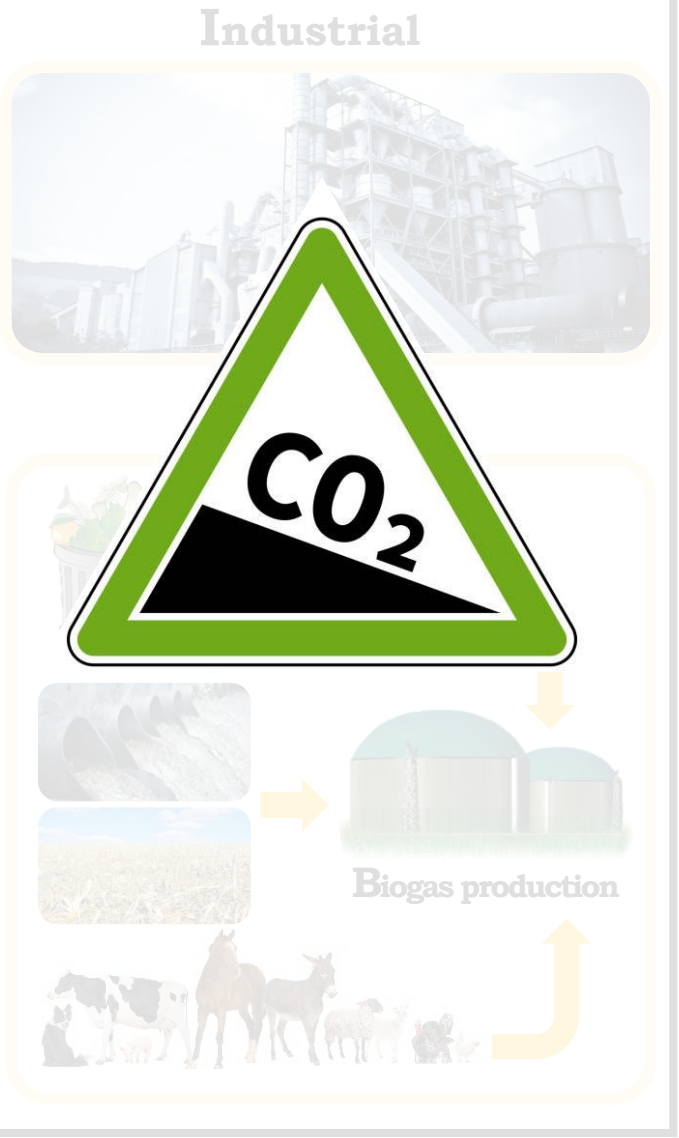
CONTEXT

EMISSIONS SOURCES



ABATEMENT STRATEGIES

CAPTURE AND SEPARATION

- Sorbents
- Membranes
- Solvents
- Cryogenic distillation

UTILIZATION

NON-CONVERSION

- Heat transfer
- Solvent
- Working fluid

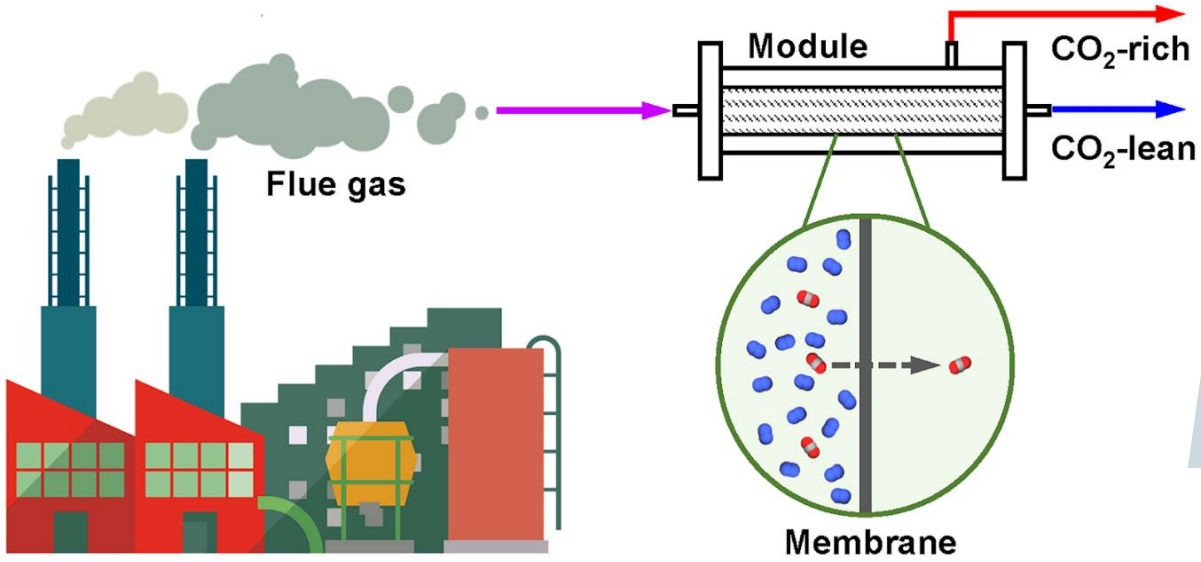
CONVERSION

- Chemicals
- Fuels

STORAGE

2. Separation

Poly(IL)-IL Membranes



IL: Ionic Liquid

Research projects

Designing poly(ionic liquid)-based engineered membranes for hydrogen purification

PTDC/CTM-POL/2676/2014

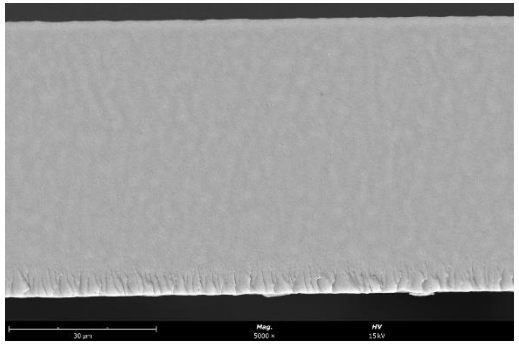
Molecular and Engineering Thermodynamics (MET)

Bruna Soares

Isabel Marrucho

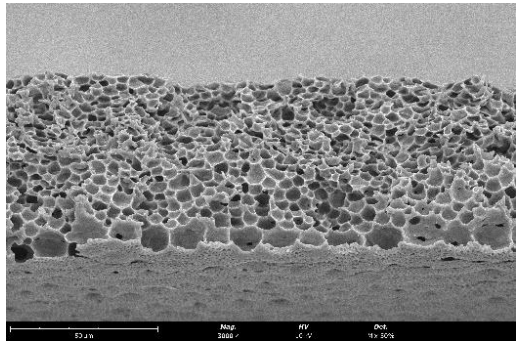
Membrane type

Dense membranes



High selectivity

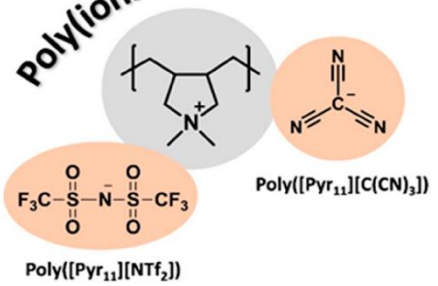
Asymmetric membranes



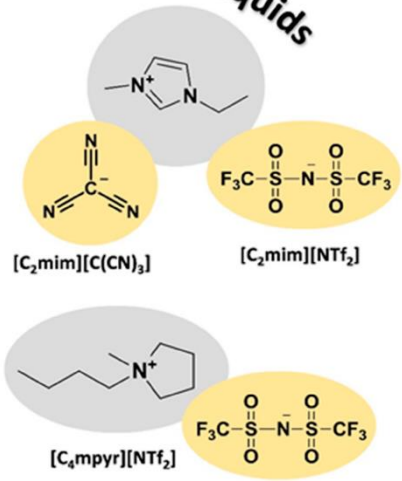
High gas flux

Membrane material

Poly(ionic liquid)s



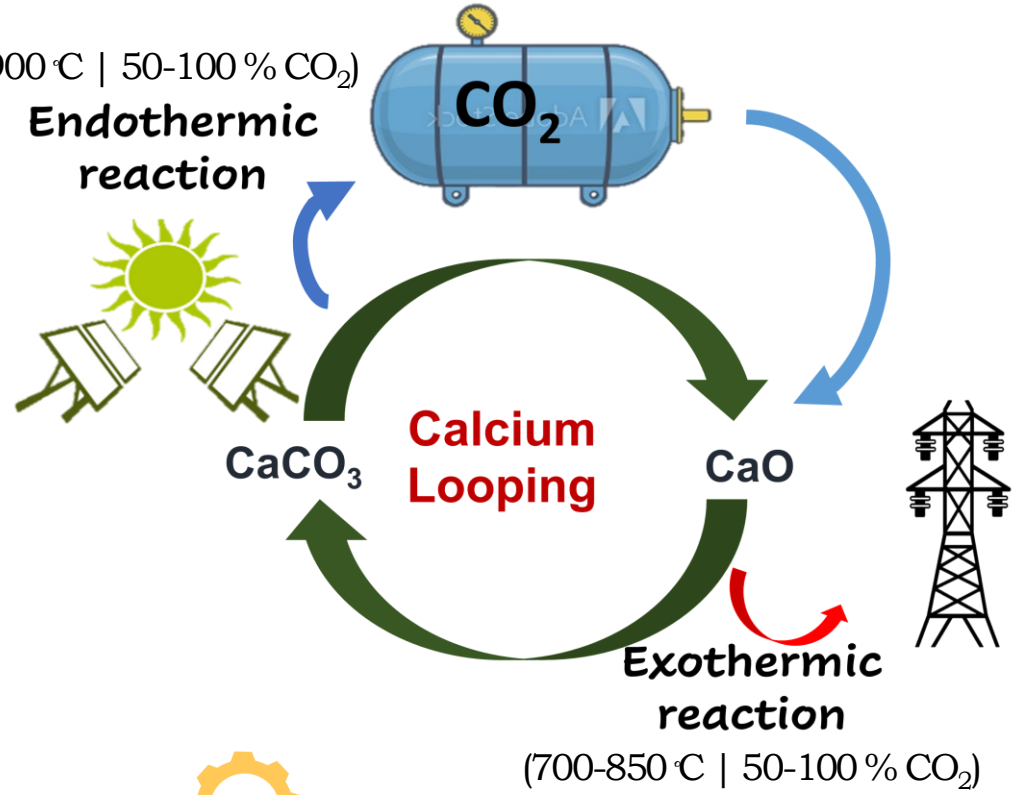
Ionic Liquids



3. Utilization

3.1. Non-conversion

Ca-Looping for thermochemical energy storage (TCES)

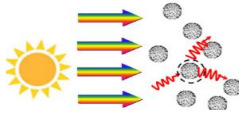


Main advantages

- ✓ High **energy storage density** (1790 kJ/kg $CaCO_3$)
- ✓ Work at **high power cycle temperatures** (e.g., >800 °C)
- ✓ Synergy with the **cement industry**

Main drawbacks

- ✓ Sorbents **deactivation** due to sintering
- ✓ Low **solar absorptance** of most calcium carbonates (relevant for directly irradiated reactors)



Research projects

SoCaLTes

Solar-driven Ca-Looping Process for Thermochemical Energy Storage

PTDC/EAM-PEC/32342/2017

Paula Teixeira

Carla I. C. Pinheiro

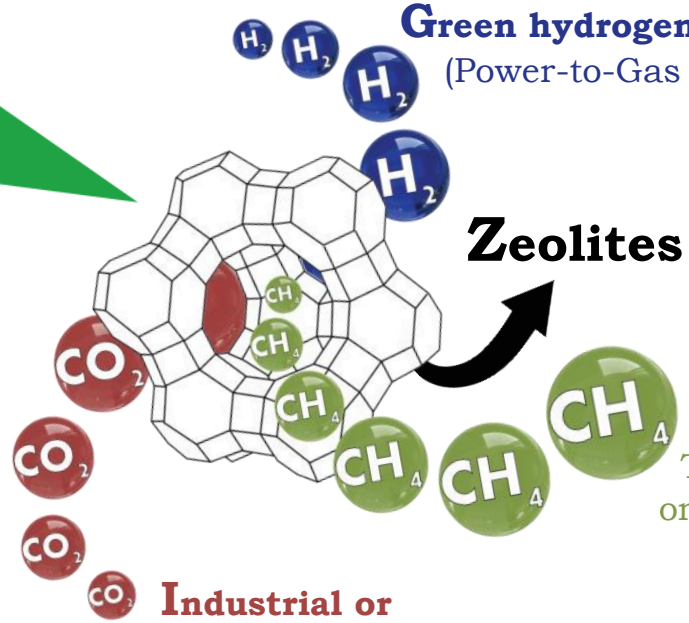
CO_2@CQE

3. Utilization | 3.2. Conversion | B) Methane

Thermal and plasma-assisted catalysis

Sabatier reaction

$$CO_2 + 4H_2 \longleftrightarrow CH_4 + 2H_2O$$



Suitable catalytic supports

ChemCatChem, 2019, **11**, 2388

- ✓ Identification of **key catalytic properties** (e.g., hydrophobicity)
- ✓ Optimized catalysts **better** than **commercial** methanation materials

Research projects

C5Lab Sustainable Construction Materials Association — **WP3** – Methane synthesis and water electrolysis

CEOPS – CO_2 - Loop for Energy storage and conversion to Organic chemistry Processes through advanced catalytic Systems (*FP7-NMP/309984*)

Carmen Bacariza

Carlos Henriques

José M. Lopes

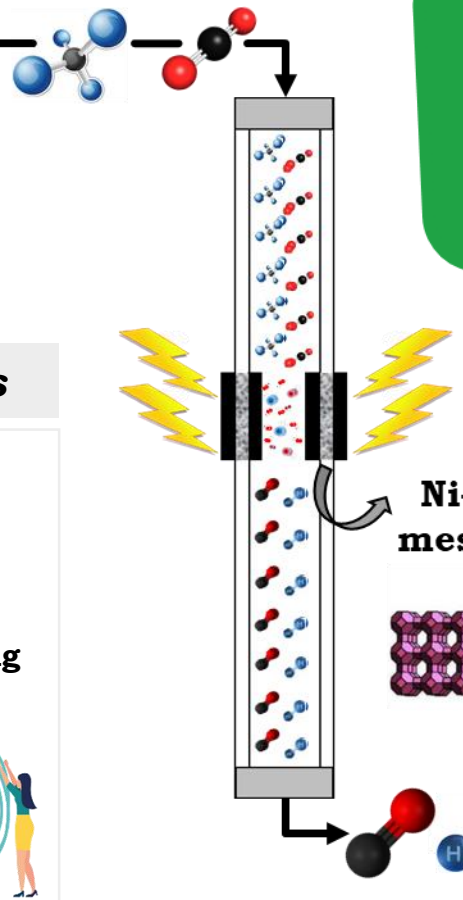
3. Utilization | 3.2. Conversion | D) Bio-syngas

Plasma-assisted catalysis

Biogas

50-70% CH_4

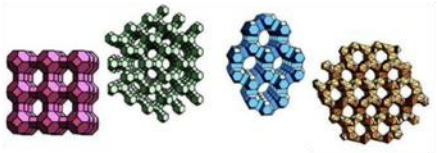
30-50% CO_2



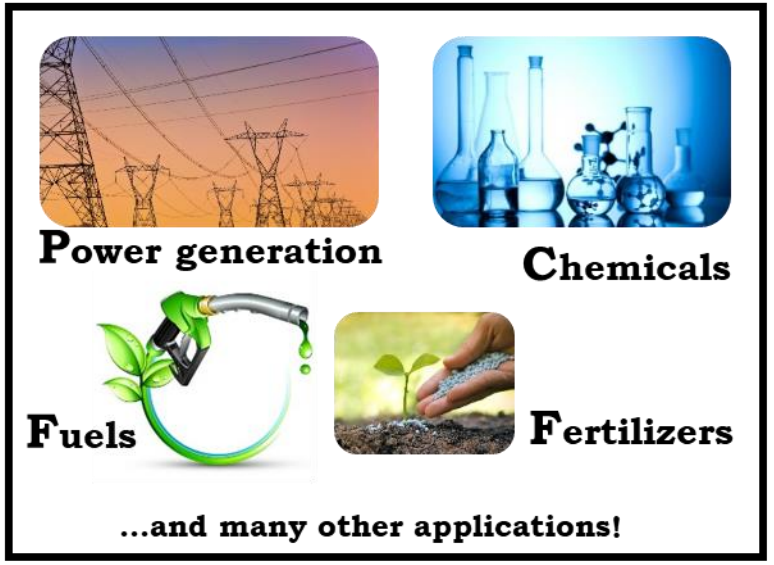
Dry reforming of methane

$$CO_2 + CH_4 \rightleftharpoons 2CO + 2H_2$$

Ni-based micro and mesoporous catalysts



Bio-syngas



Some challenges

Plasma conditions optimization

Catalyst – Plasma synergies understanding

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