University of BRISTOL

Faul Research Group

Functional Porous Polymer · CO_2 Capture & Conversion · Electroactive and Soft Materials · 3D Printing

WATER PROOF
Final Workshop
Amsterdam

Metal-free Porous Polyimide Networks for CO_2 Capture and Conversion

LinkedIn

- Capturing CO_2
- Converting to Formic Acid & Cyclic Carbonates
- Enabling a Sustainable Carbon Economy

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1. Introduction

1 tree absorbs ~22 kg CO_2/year

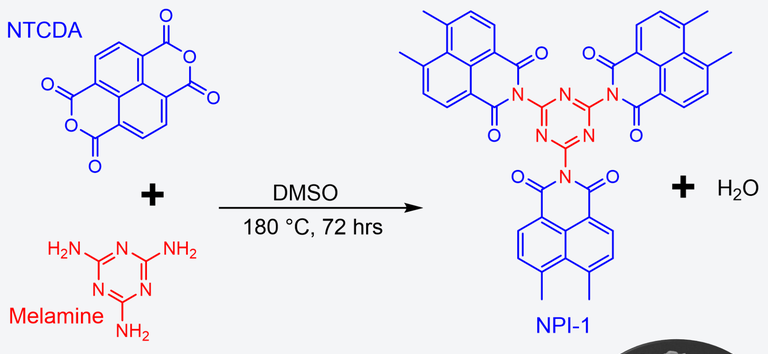
= 1.9 trillion trees to offset our emission

Nature-inspired porous materials offer a sustainable route to capture CO_2 and convert it into value-added chemicals, complimenting existing processes

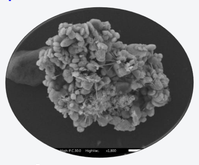


HIGH-VALUE Products

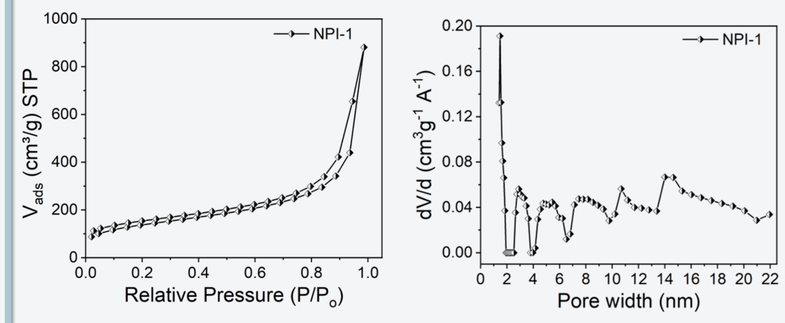
2. Porous Materials Design



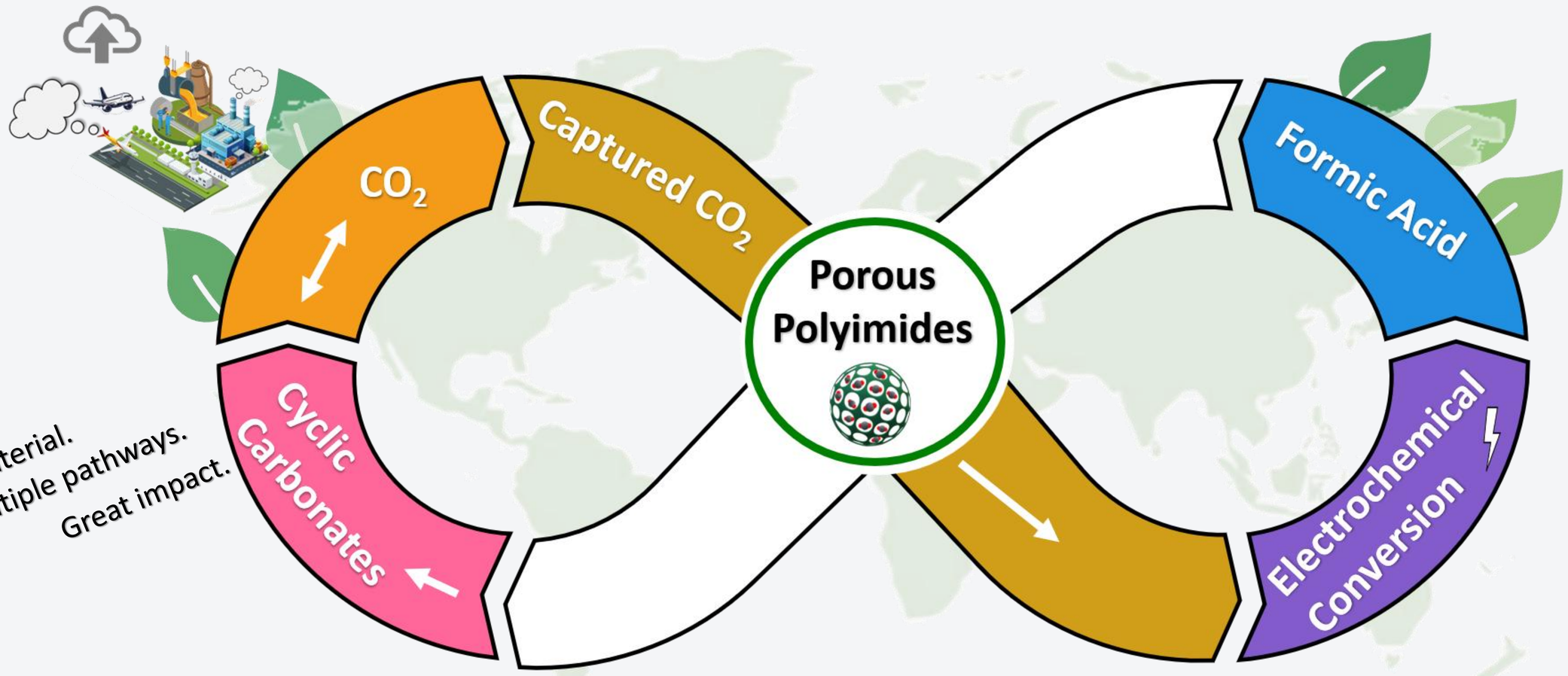
- Metal-free catalyst
- Tunable porosity & functionality
- CO_2 activation properties
- For catalysis & electrochemical application



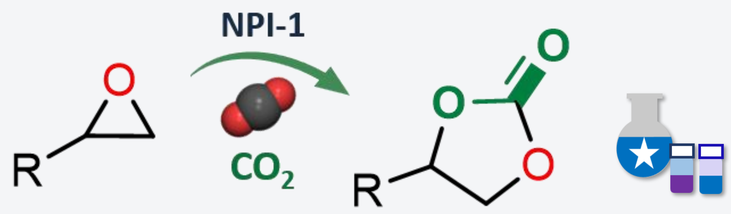
3. Material Characterisation



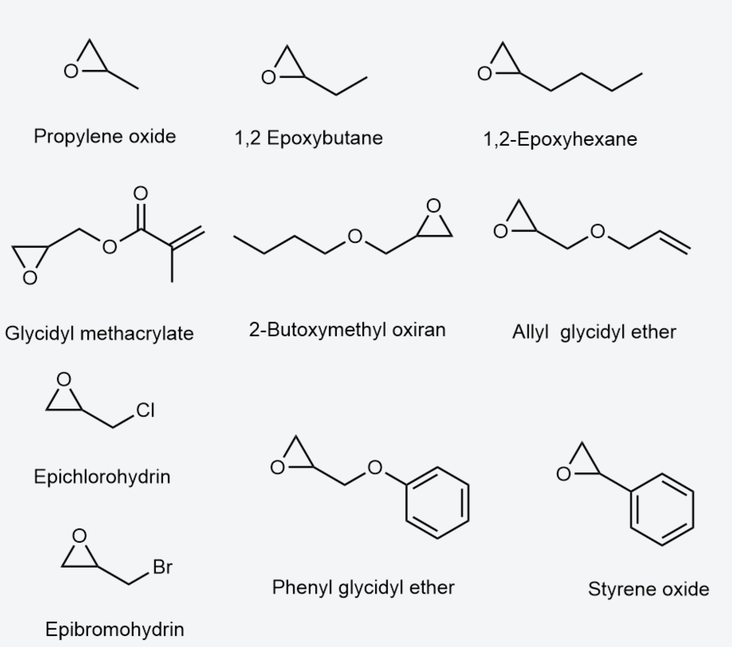
Material	S_{BET} ($m^2 g^{-1}$)	V_{pore} ($cm^3 g^{-1}$)	CO_2 uptake (wt%)		Q_{st} (kJ mol^{-1})
			273 K	298 K	
NPI-1	460	0.92	6.8	4.7	29



4. Cyclic Carbonates Formation



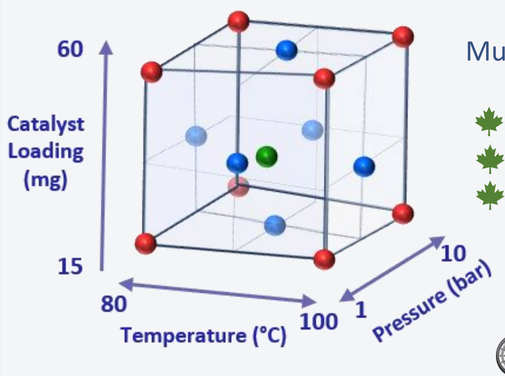
- Statistically optimised conditions (T / P / Cat. Loading)
- High conversion and selectivity
- Reuseable catalyst
- Efficient CO_2 utilisation



5. Optimisation via DoE CCF

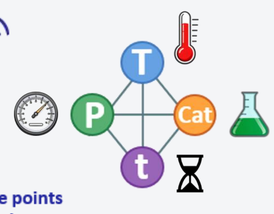
Central Composite Faced (CCF) Design of Experiments (DoE)

3 Factors, 3 levels → **17 experiments** (including 3 centre points)



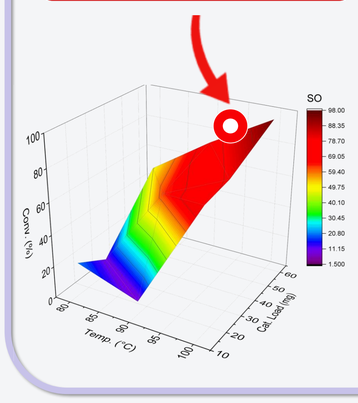
DoE (CCF)
Multiple variables at once

- Captures interactions
- Efficient & fewer runs
- Higher accuracy



Factorial points (8 runs) · Face-centre points (6 runs) · Centre points (3 runs)

Optimal conditions



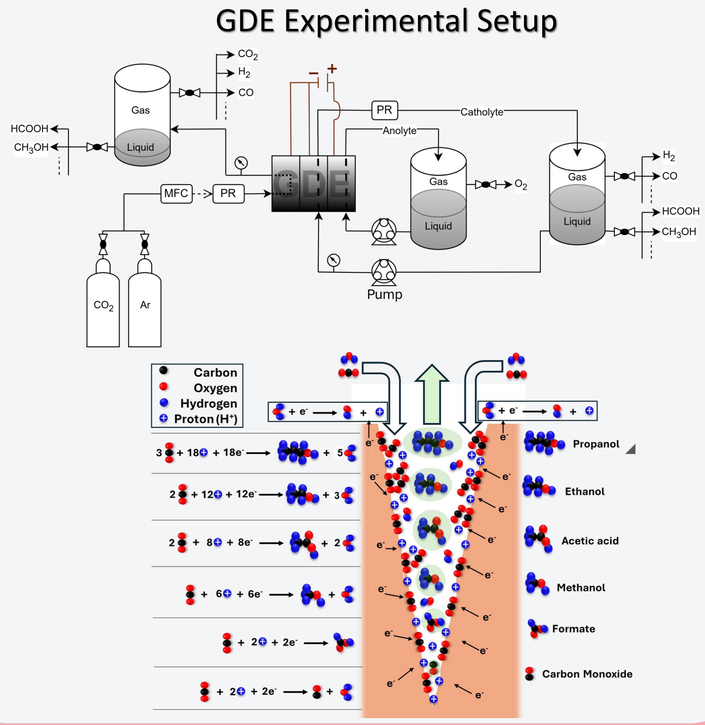
Design Variable & Ranges

Factors	Range
Temperature (°C)	80 - 100
Pressure (bar)	1 - 10
Catalyst Loading (mg)	15 - 60

Response
Conversion (%) at 48 h

6. Electrochemical CO_2 Reduction

GDE Experimental Setup



1. B. B. Narzary, et al., Polymer Chemistry, 2021, 12, 6494-6514
2. B. B. Narzary, et al., Mater. Chem. Front., 2023, 7, 4473–4481
3. U. Karatayeva, et al., Adv. Sci., 2024, 11, 2308228

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