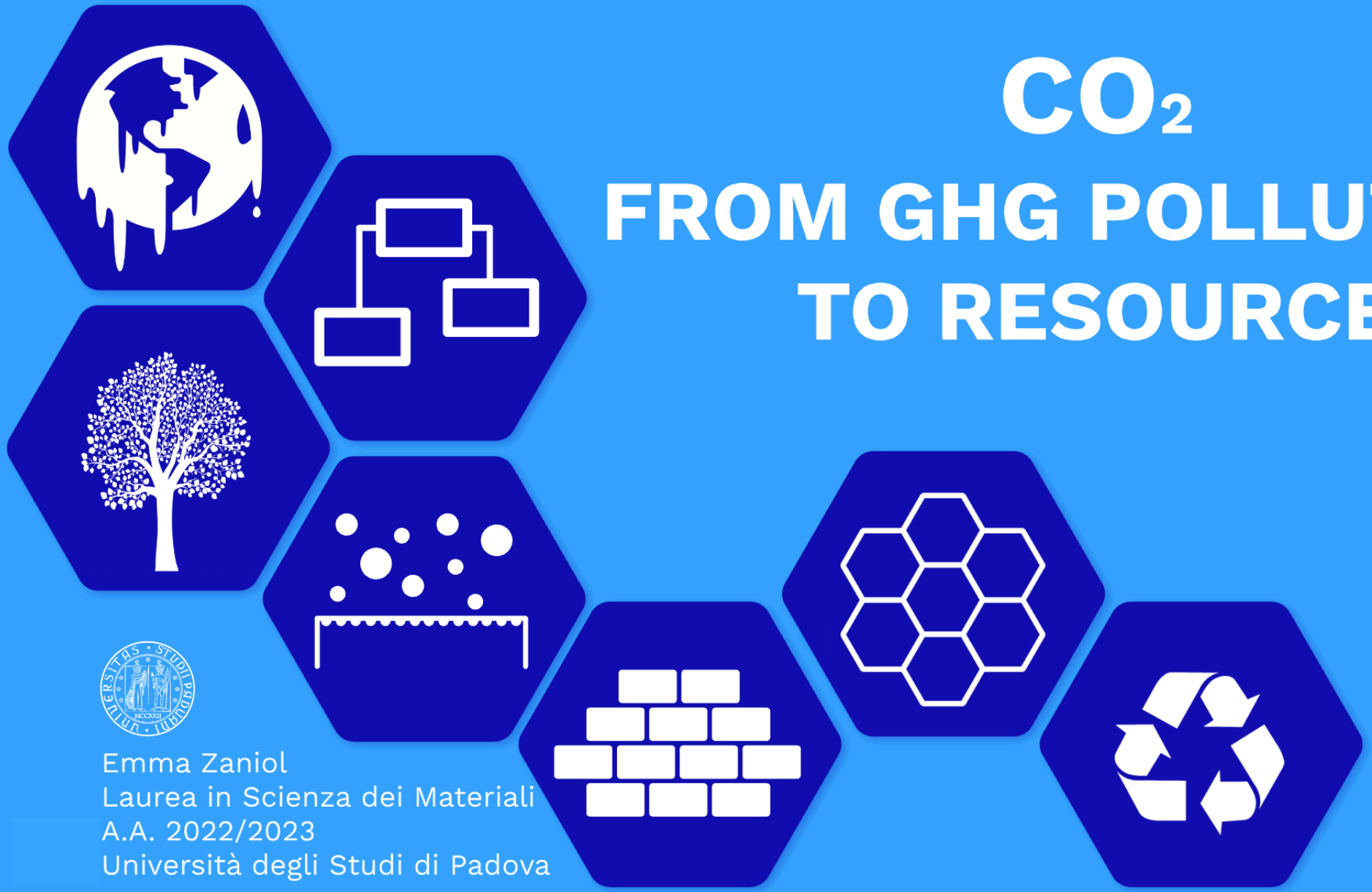

CO_2 FROM GHG POLLUTANT TO RESOURCE

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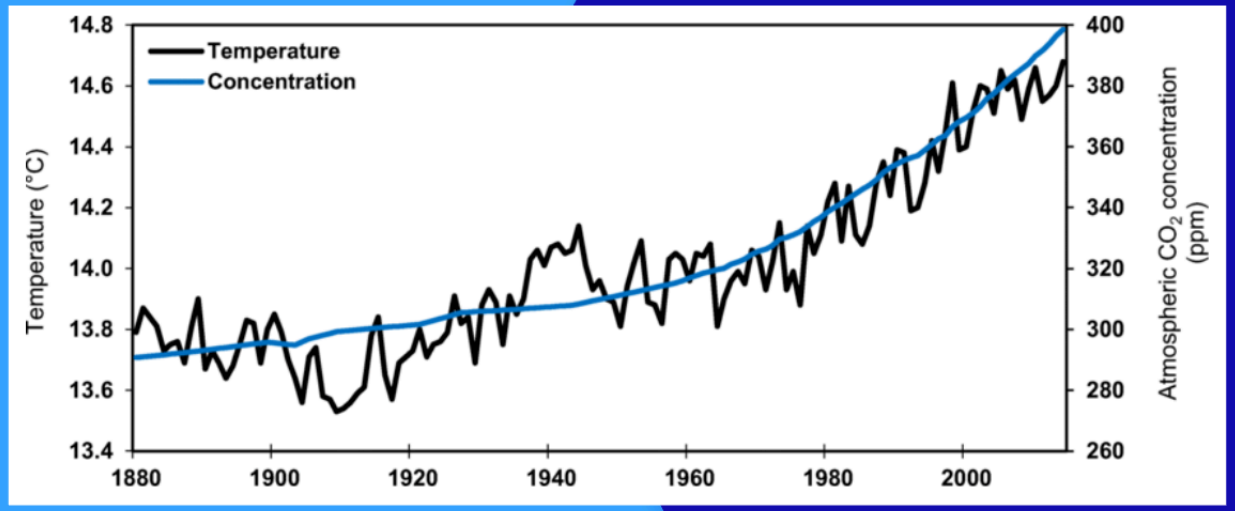
Laurea in Scienza dei Materiali
A.A. 2022/2023
Università degli Studi di Padova

GREENHOUSE GASSES



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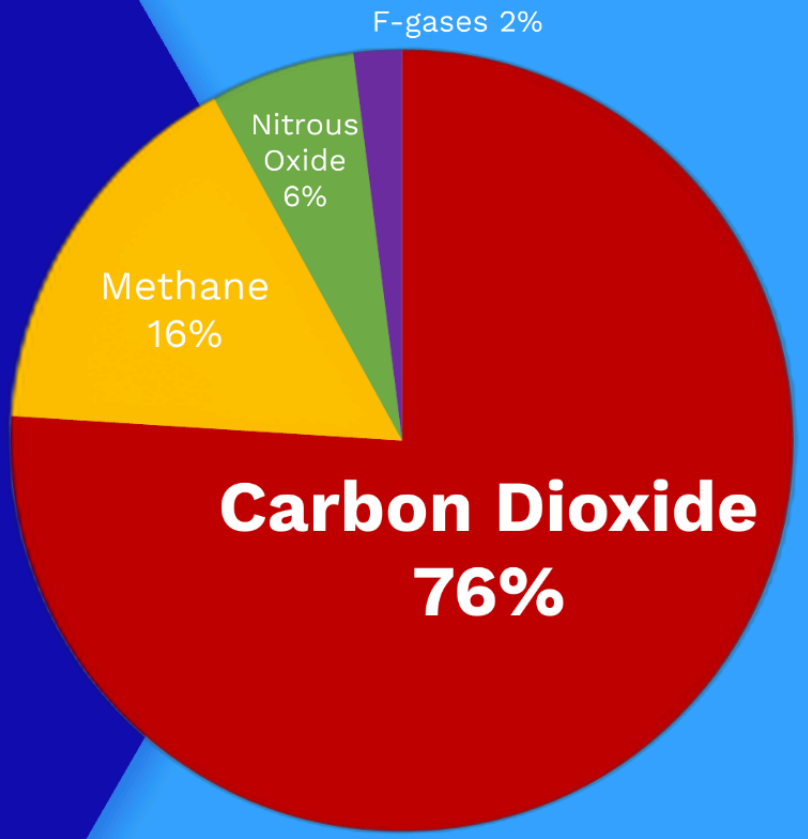
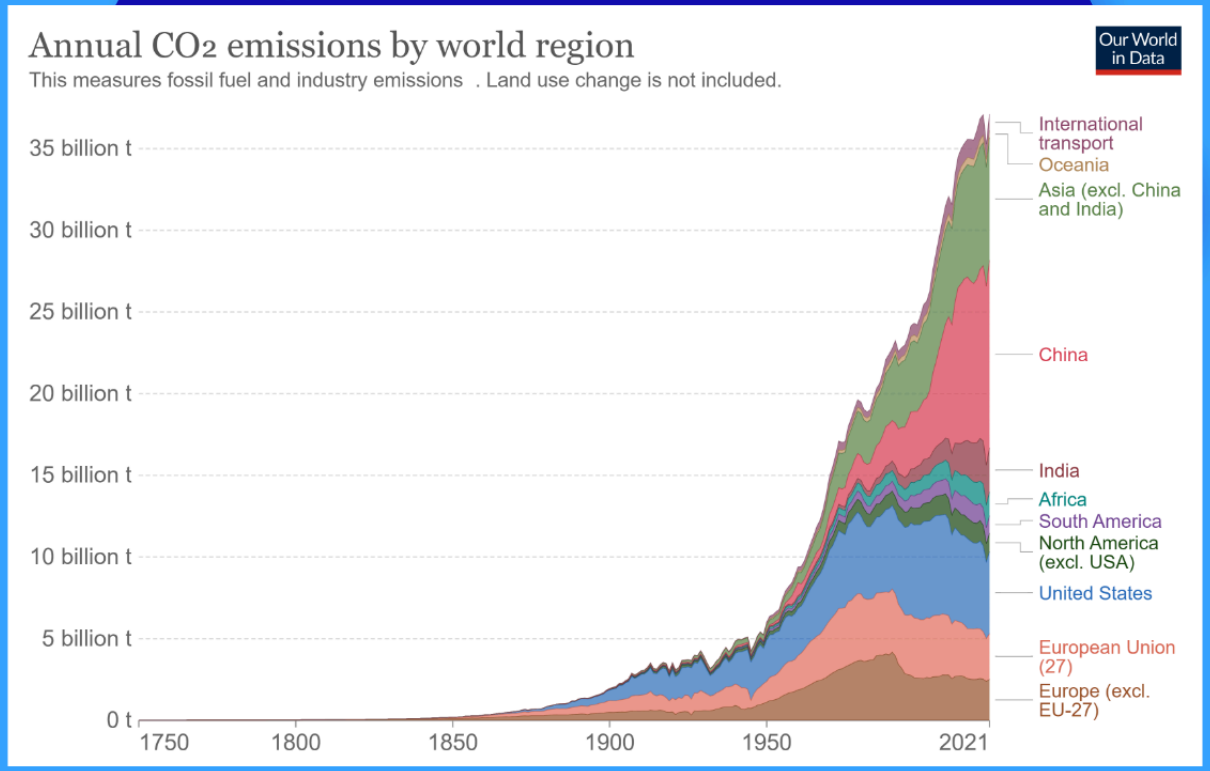


Ref: 16

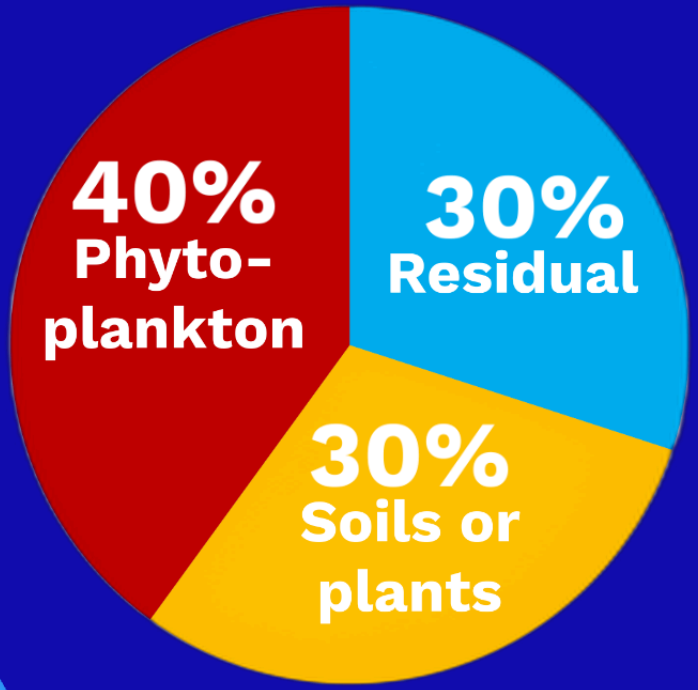
36,8 Gt of CO_2

global emissions in 2022



Ref: 12 e 15

CO_2 ABSORBED



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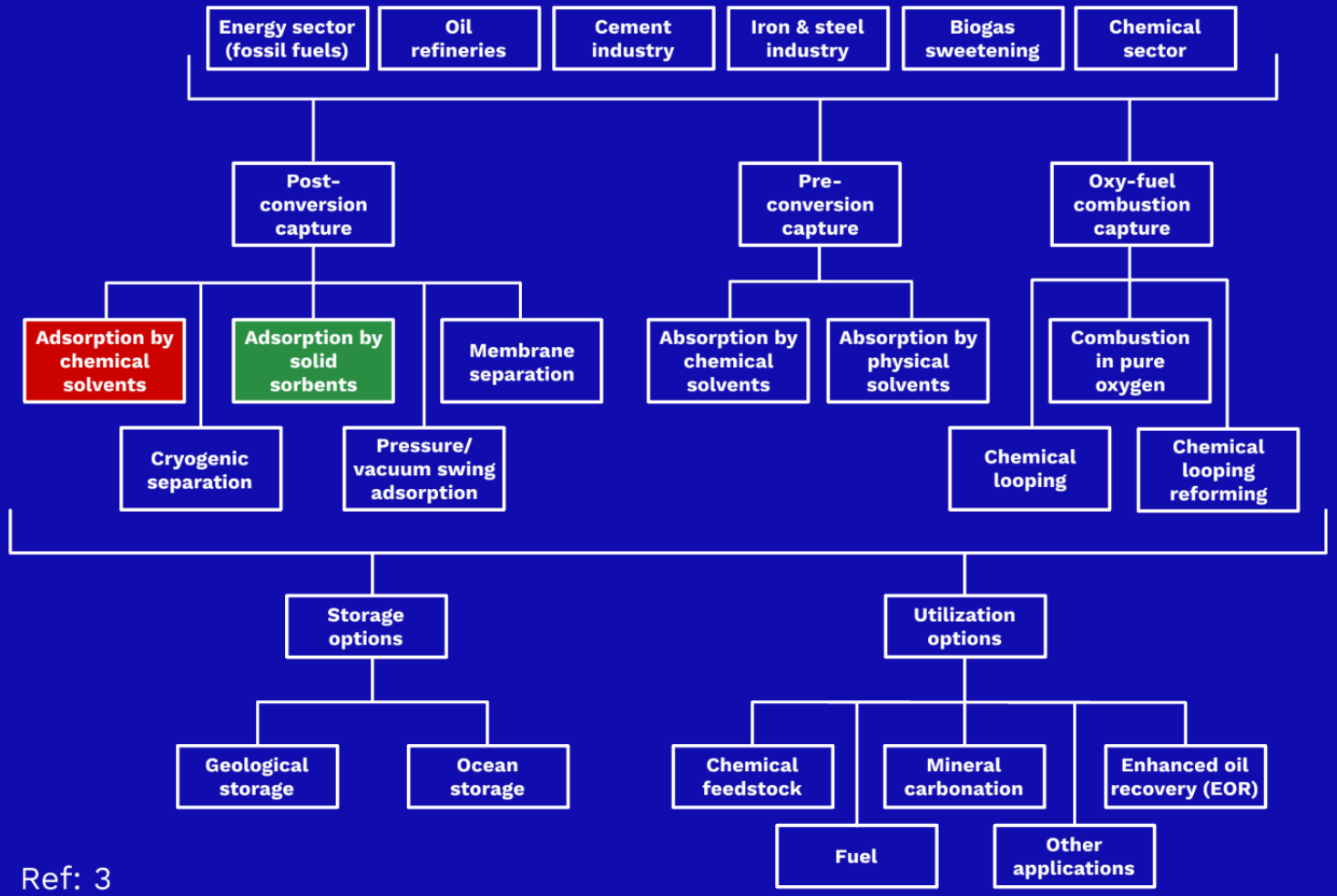
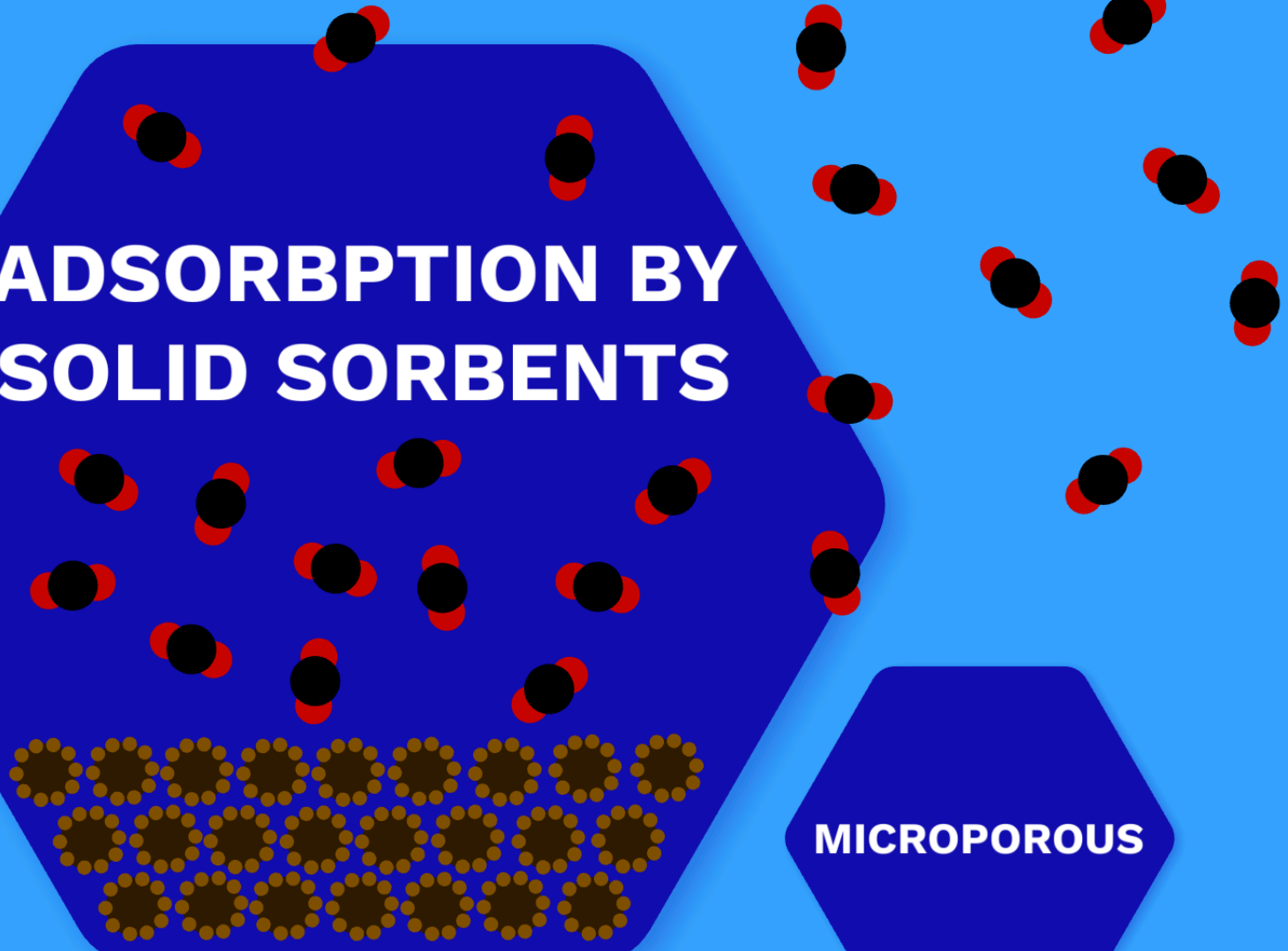
CARBON CAPTURE AND STORAGE / UTILIZATION



Ref: 3

ADVANTAGES

ADSORBPTION BY SOLID SORBENTS



PARAMETERS

MICROPOROUS

ADVANTAGES

- Low energy requirement
- Cost advantage
- No corrosive liquids
- Ease applicability
- Wide range of T and P
- High CO_2 selectivity
- High adsorption capacity
- Durable
- Easily regenerable

PARAMETERS

Pressure

Temperature

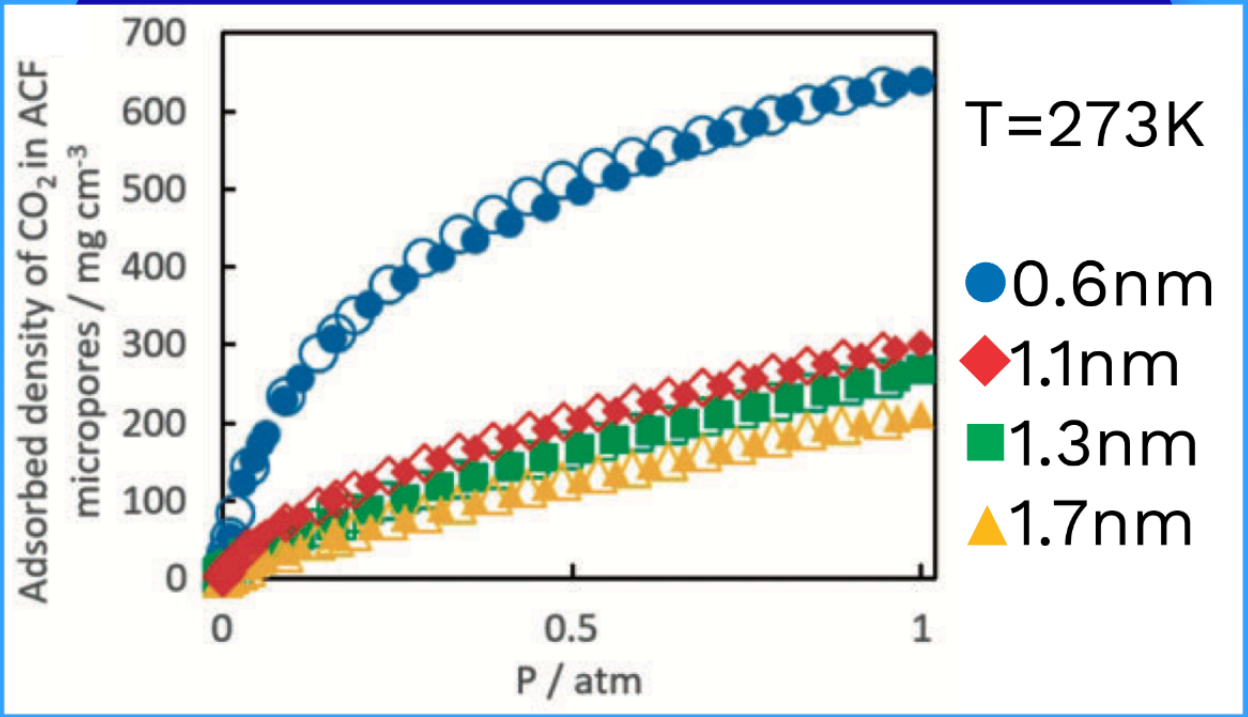
Microstructure

Superficial forces

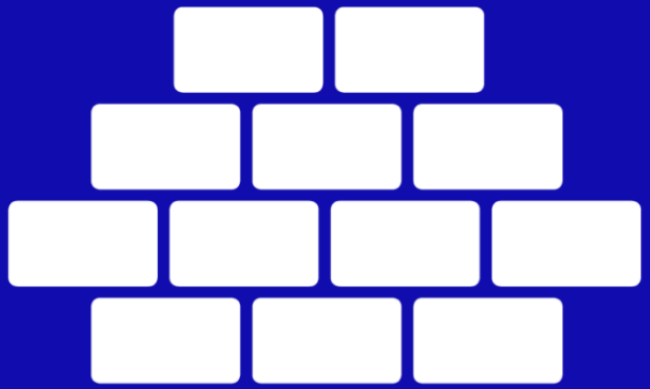
MICROPOROUS

<1.1nm optimal pore size range of CO_2 adsorption

Ref: 4

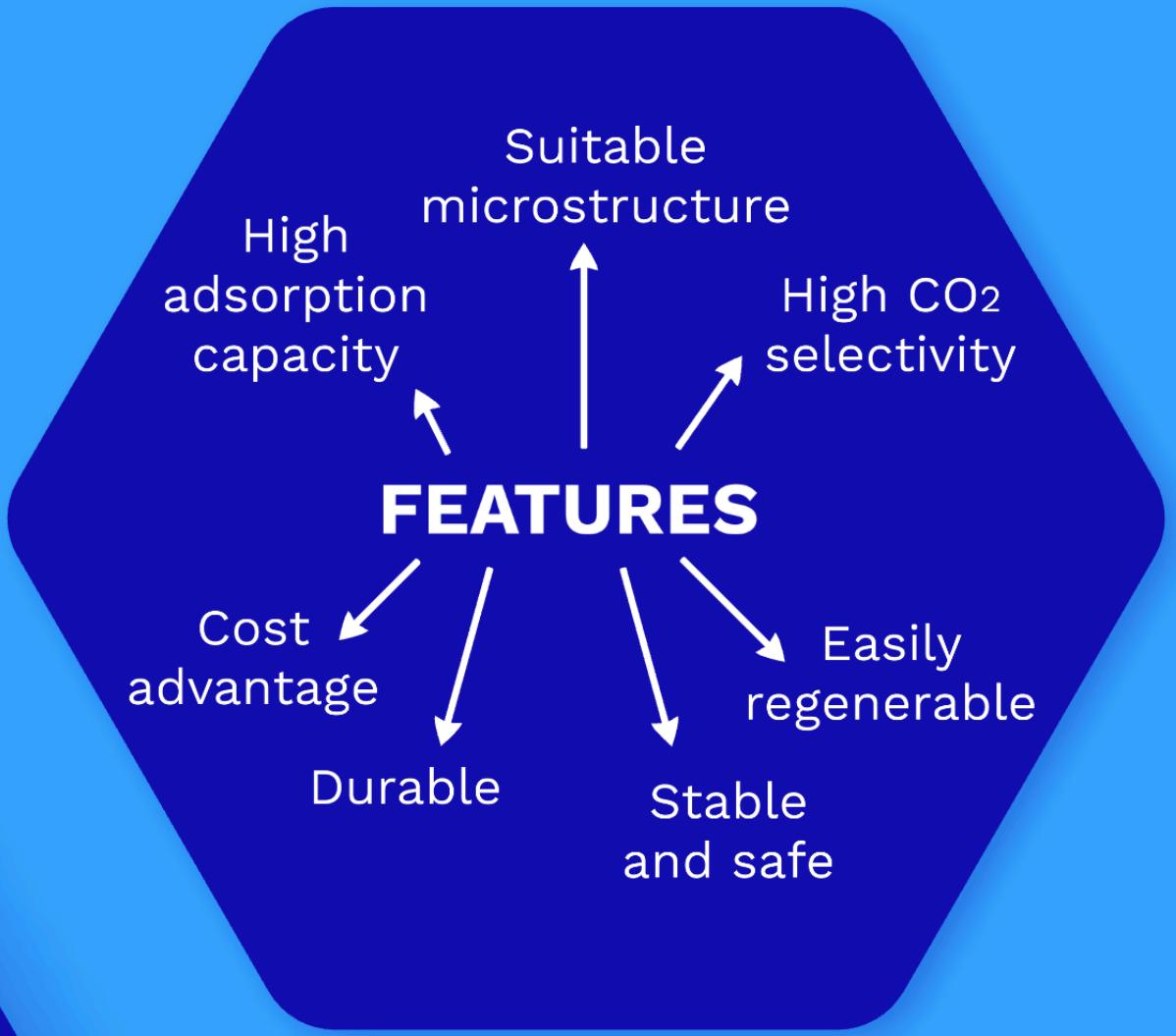


MATERIALS



FEATURES

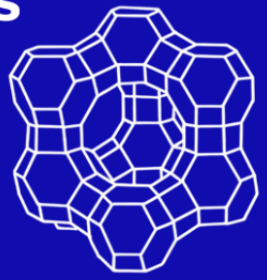
MAIN


Suitable microstructure
High adsorption capacity
High CO_2 selectivity
FEATURES
Cost advantage
Durable
Stable and safe
Easily regenerable

CARBONACEOUS MATERIALS

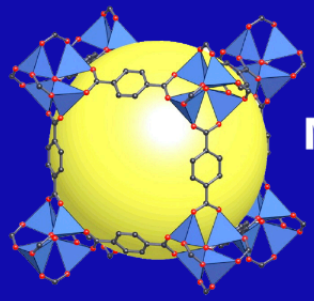
Low selectivity of CO_2
Large decrease in adsorption with slight increase in temperature
Water inhibits the adsorption capacity

ZEOLITES



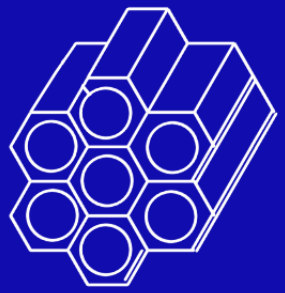
High adsorption capacity
Porous materials
Large surface area
High stability

MAIN



MOFs

MESOPOROUS SILICA MATERIALS



ACTIVATED CARBONS

- High specific area
- Suitable pore sizes
- High adsorption capacity
- Low temperature and pressure
- Easily regenerable
- Economic and safe

SURFACE

ACID SITES

BASIC SITES

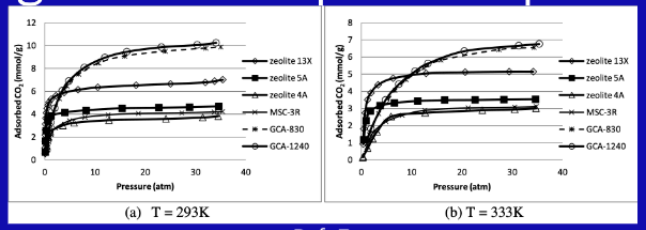
CHARACTE-RIZATION

COMPARISON ZEOLITES

COMPARISON ZEOLITES

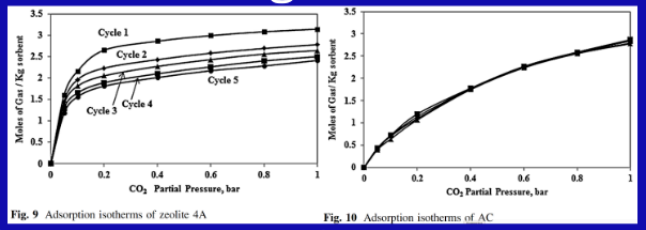
Do not require any moisture removal

Highest adsorption capacity



Ref: 7

Full regeneration



Ref: 8

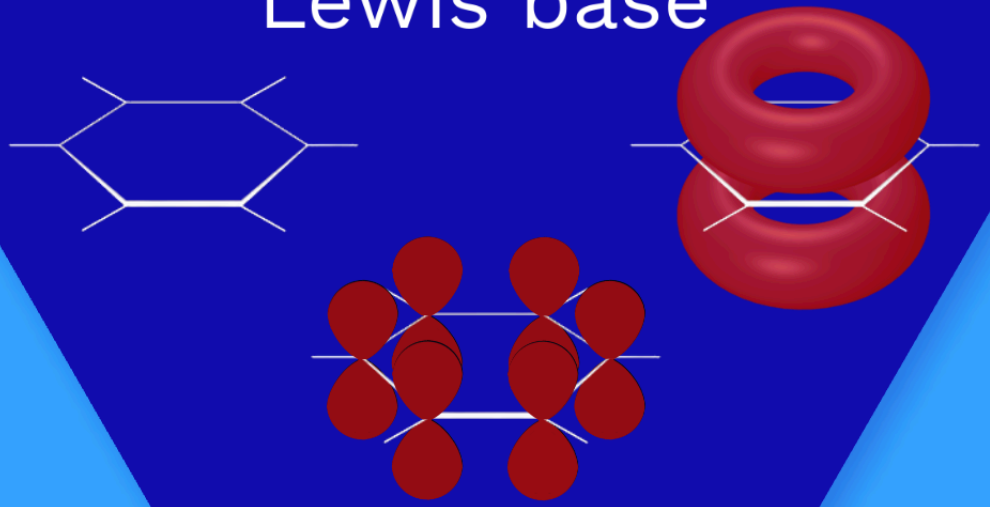
Delocalized π-electrons

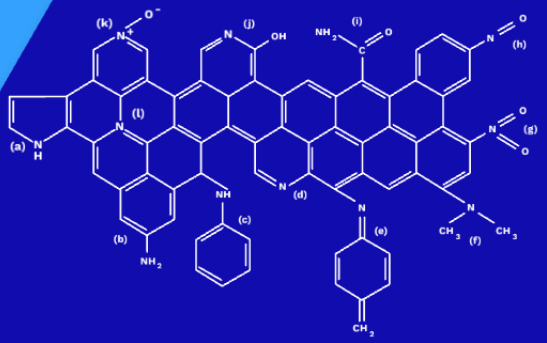
Basic sites

BASICITY OF SURFACE

Delocalized π-electrons

act like
Lewis base





(a) pyrrole
(b) primary amine
(c) secondary amine
(d) pyridine
(e) imine
(f) tertiary amine
(g) nitro
(h) nitroso
(i) amide
(j) pyridone
(k) pyridine-N-oxide
(l) quaternary nitrogen

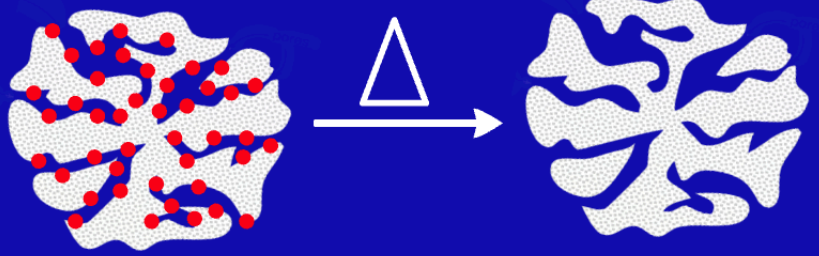
Basic sites with nitrogen functional groups

Modify the pore textural properties → Increase selectivity

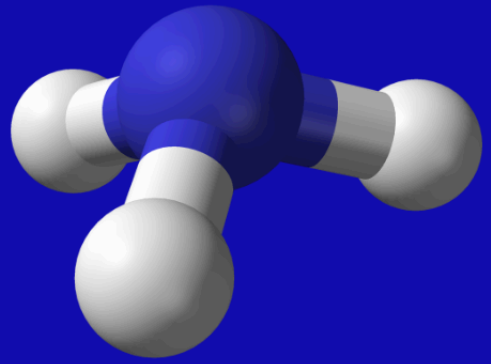
Strengthened interaction CO_2 - surface → Lewis acid-base; Hydrogen bonding

HEAT TREATMENT

to remove acid sites



AMMONIA TREATMENT



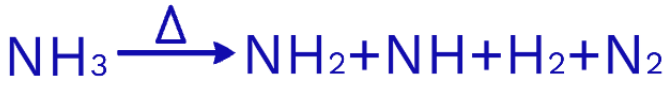
TO INTRODUCE BASIC NITROGEN FUNCTIONALITIES

REACTIONS

GREEN NH_3

REACTIONS

1



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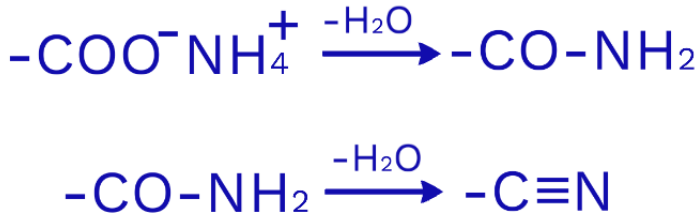

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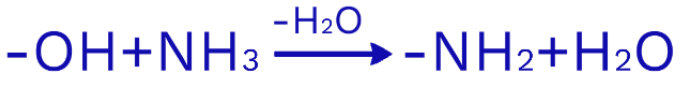

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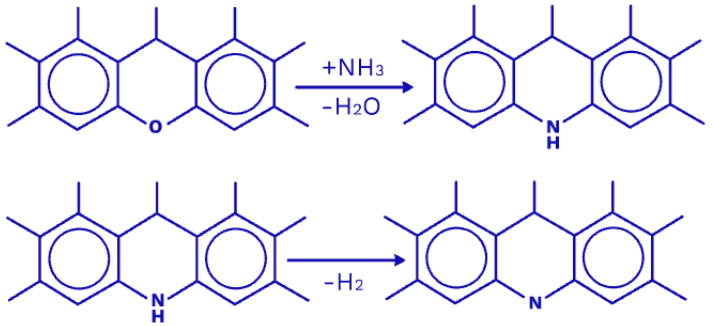
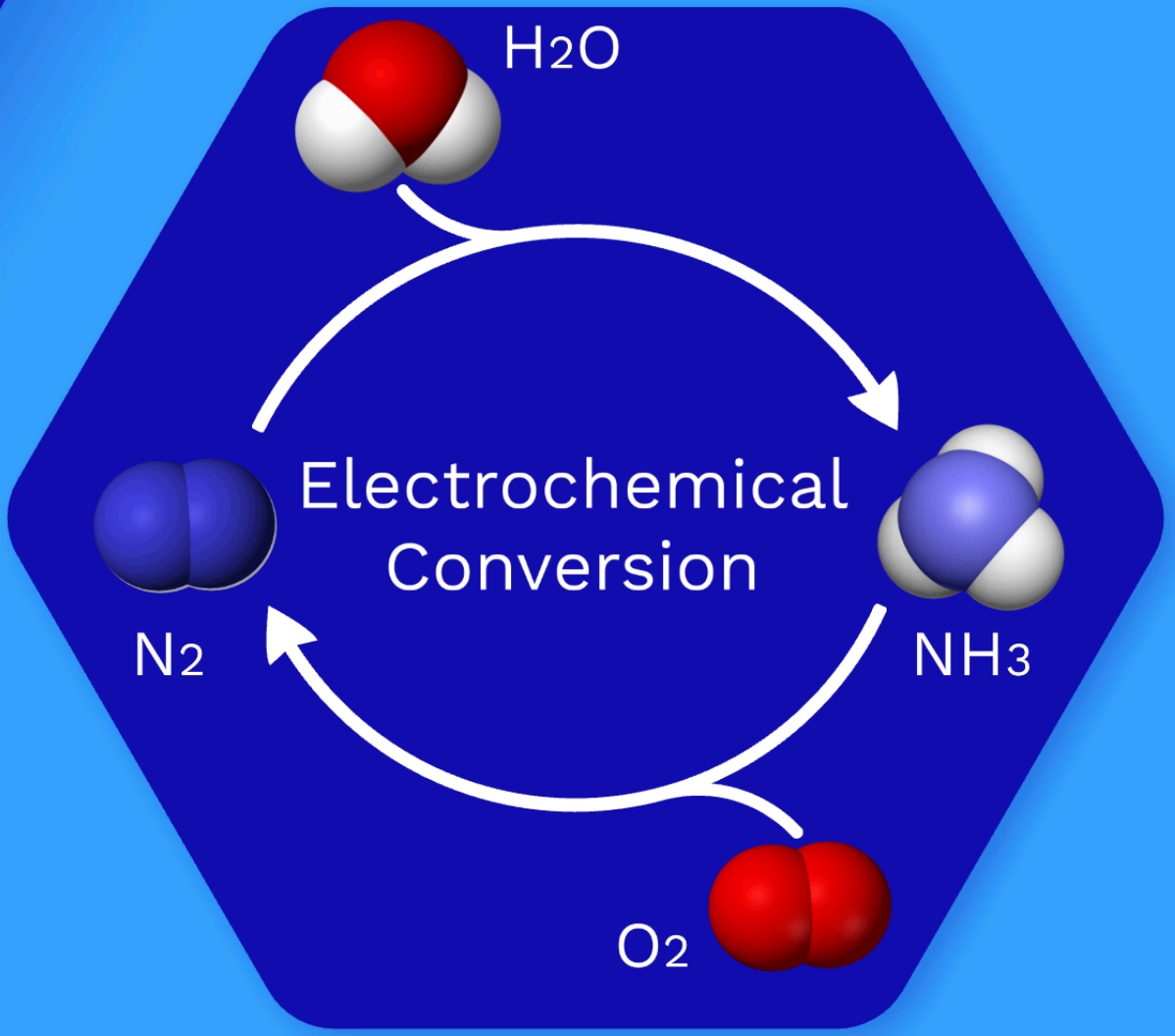
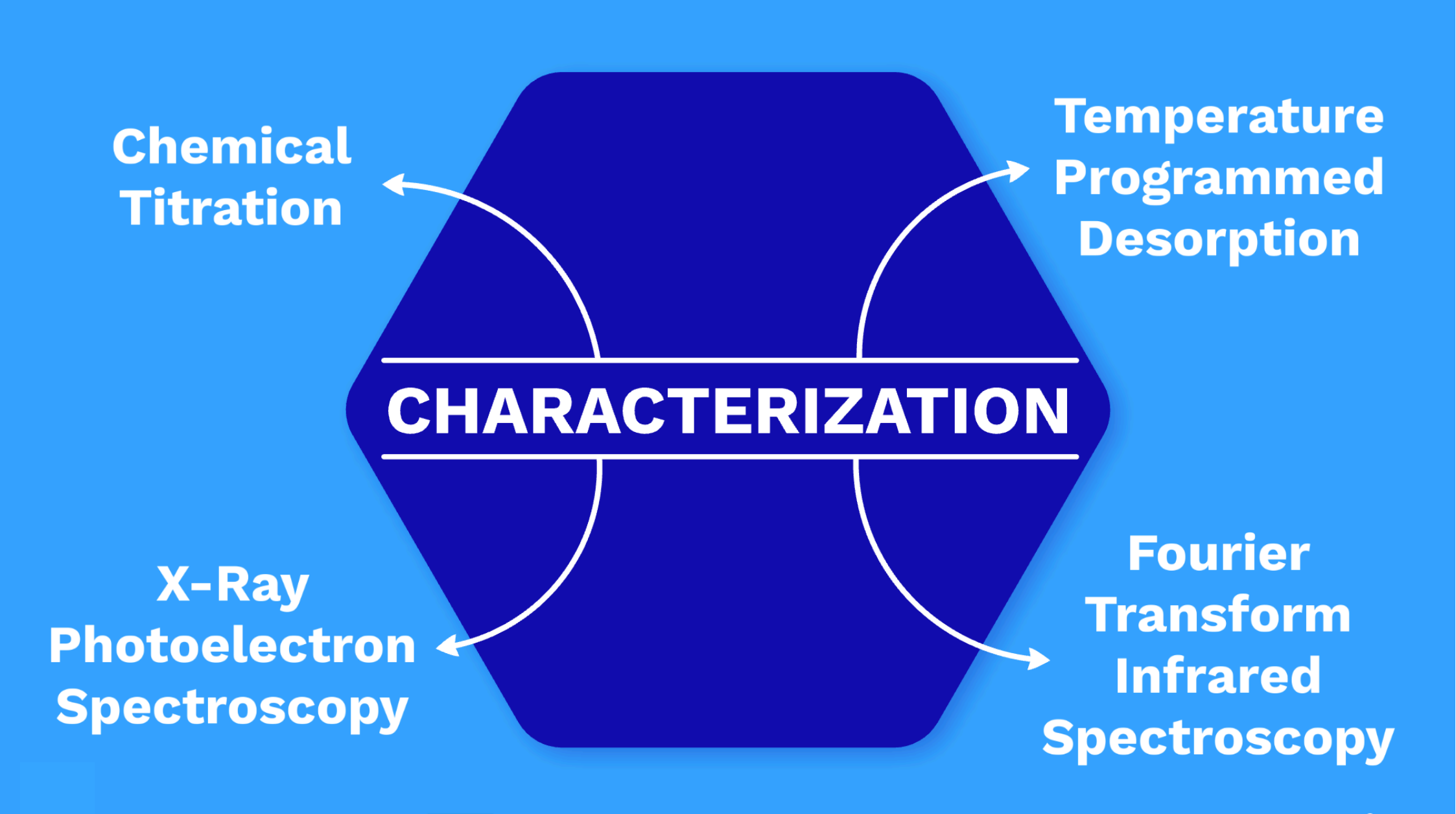



H2O
Electrochemical
Conversion
N2
NH3
O2


Chemical Titration
Temperature Programmed Desorption
CHARACTERIZATION
X-Ray Photoelectron Spectroscopy
Fourier Transform Infrared Spectroscopy

ACTIVED CARBON FROM WASTE MATERIALS

WATER FILTERS

SURGICAL MASKS

CIGARETTE FILTERS

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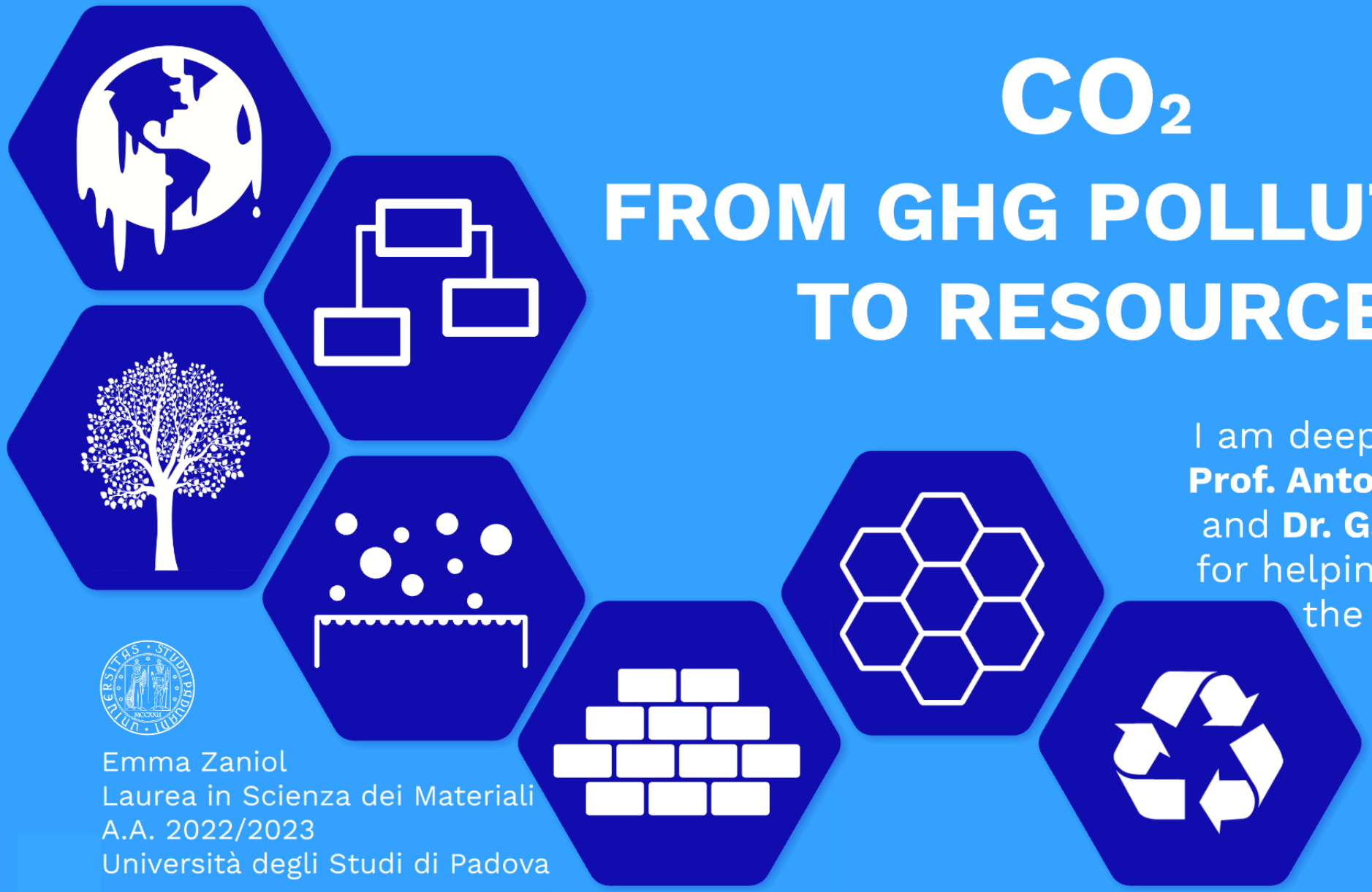

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I am deeply grateful to **Prof. Antonella Glisenti** and **Dr. Gabriel Merlin** for helping me finalize the project

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