Development of highly efficient direct air capture (DAC) and carbon recycling technologies

Kanazawa University

Research Institute of Innovative Technology for the Earth
RITE

Introduction

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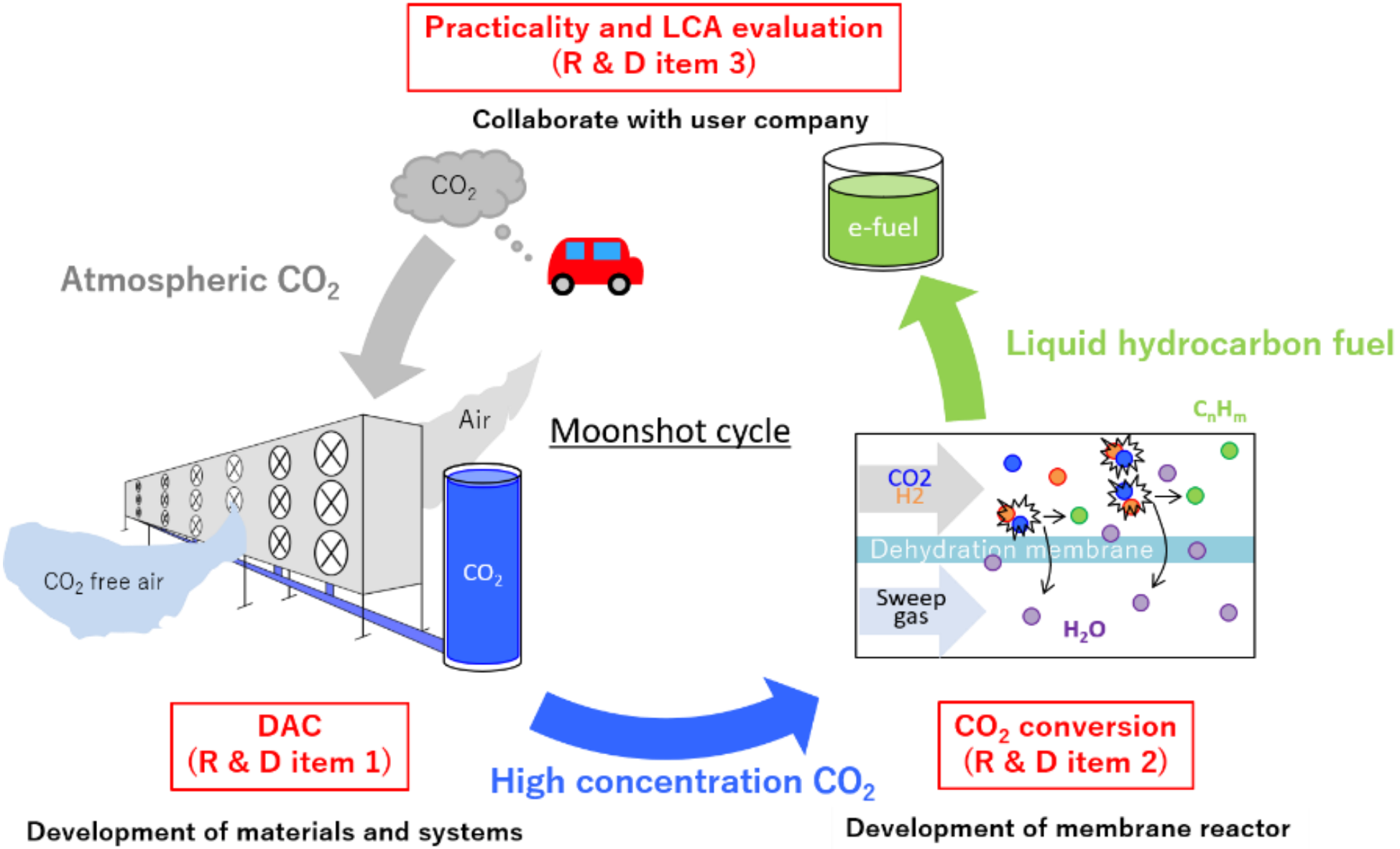
Areas of expertise

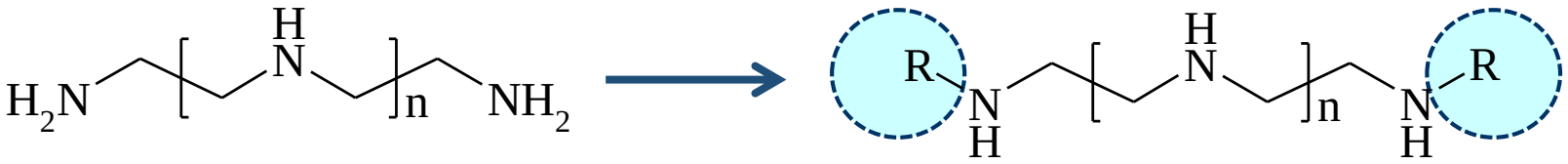
Adsorption processes:

- ☐ Thermal swing adsorption
  - • CO_2 recovery and Direct Air Capture
  - • Air separation
  - • Solar / low-grade heat driven desiccant dehumidification and cooling process
- ☐ Pressure swing adsorption
  - • CO_2 recovery
  - • Dehumidification
  - • Isotope separation

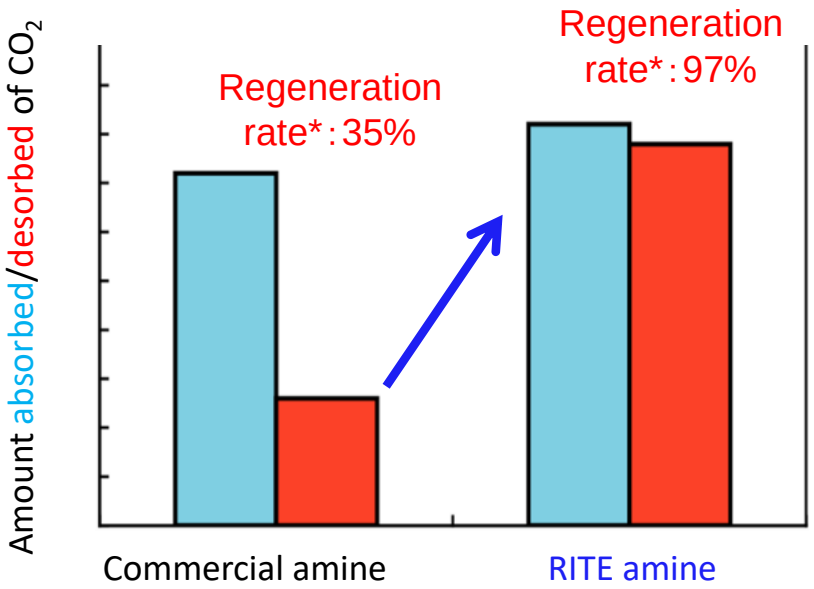
Project Overview



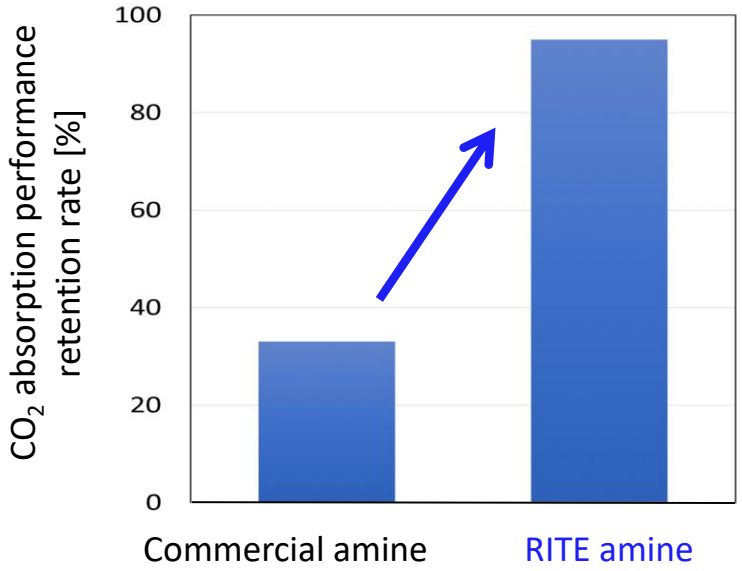
Development of Innovative Amines



Control Amine-CO_2 binding energy by customizing substituents



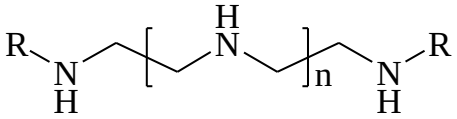
*regenerated by vacuum



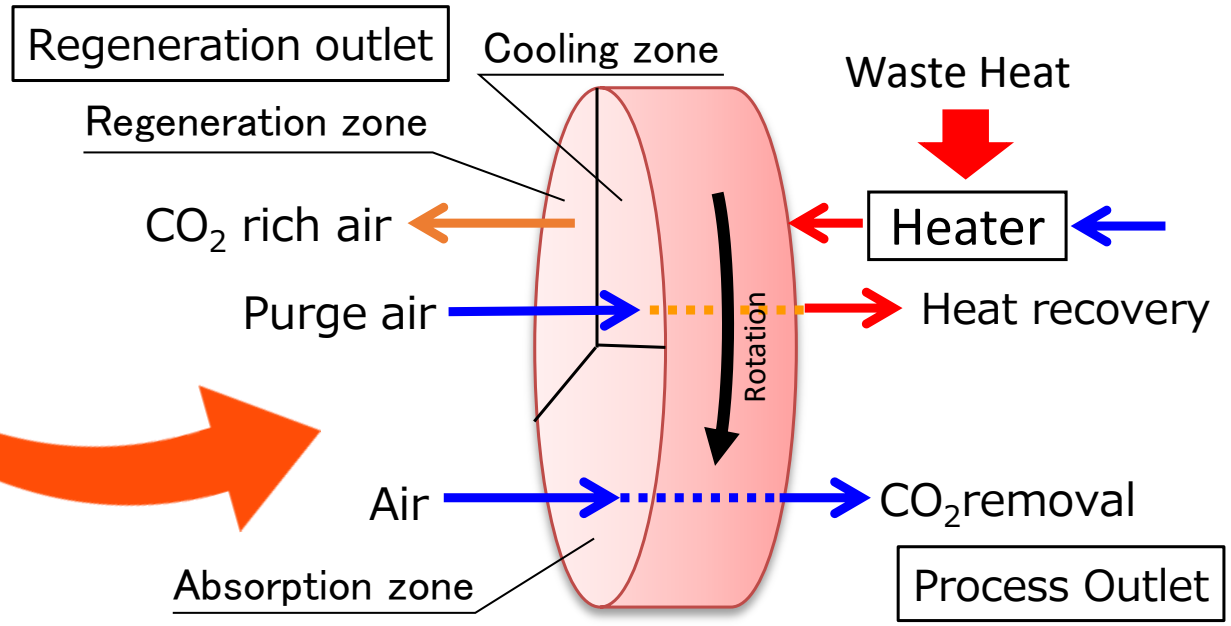
Evaluation of oxidative degradation resistance at 100° C
CO_2 (20%) / N_2 (80%) / H_2O(RH50%)

RITE sorbent can be regenerated with waste heat (60°C)

Honeycomb Rotary TSA for DAC



Innovative Amines



Amine impregnated honeycomb rotor
- Synthesis of an innovative Amines
- Support materials for impregnating

Appropriate heat management for Rotary TSA

Honeycomb Rotary TSA for DAC
- Rapid cooling of honeycomb rotor for higher CO_2 recovery ratio
- Effective heat recirculation between regeneration and absorption zones
- Effective heating of rotor with a smallest regeneration hot air flow rate

Membrane Reactor for CO_2 conversion

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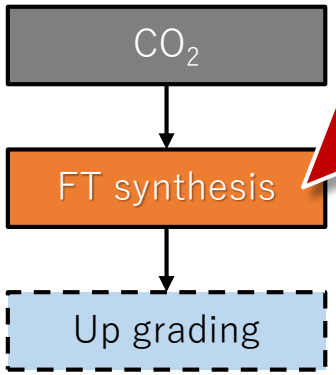
＜Our target＞

◆ Direct FT using two-types of membrane reactors



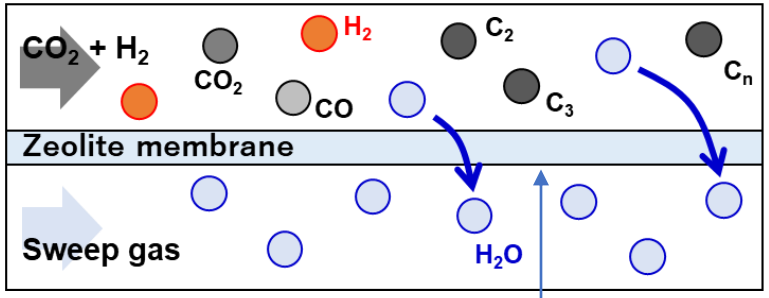
◆ H_2O-extractor type MR
⇒ Direct CO_2 conversion owing to remove H_2O molecules from reaction field (Promotion of reverse WGS reaction)

◆ H_2-distributor type MR
⇒ Controlling reaction owing to supply H_2 molecules to reaction field using membrane permeation (Anti-ASF distribution)

We expect direct FT using MR can be constructed with quite simple process, and improved C5+ yield.

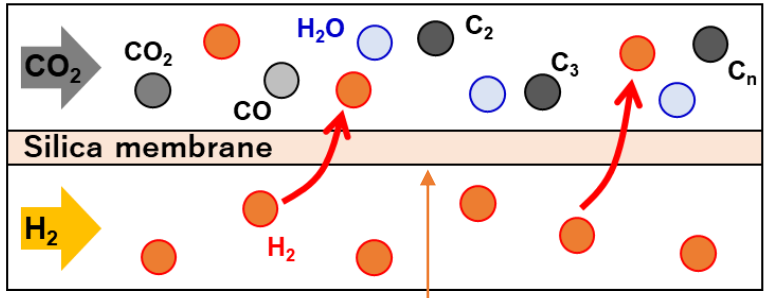
Reducing the energy consumption and the product cost

● H_2O-extractor type MR



hydrophilic nature & small-pore zeolites

● H_2-distributor type MR



uniform micro pores & thin silica layer

The Ways to Final Targets

- **High-efficiency Direct Air Capture technology**

  Innovative Amines + Honeycomb Rotary TSA

- **Conversion technology of CO_2 into valuable resources**

  Membrane reactor for Direct CO_2 conversion to liquid hydrocarbon fuel

- **Practicality assessment of the synthesized liquid hydrocarbon fuel**

  Life Cycle Assessment and collaboration with consumer companies