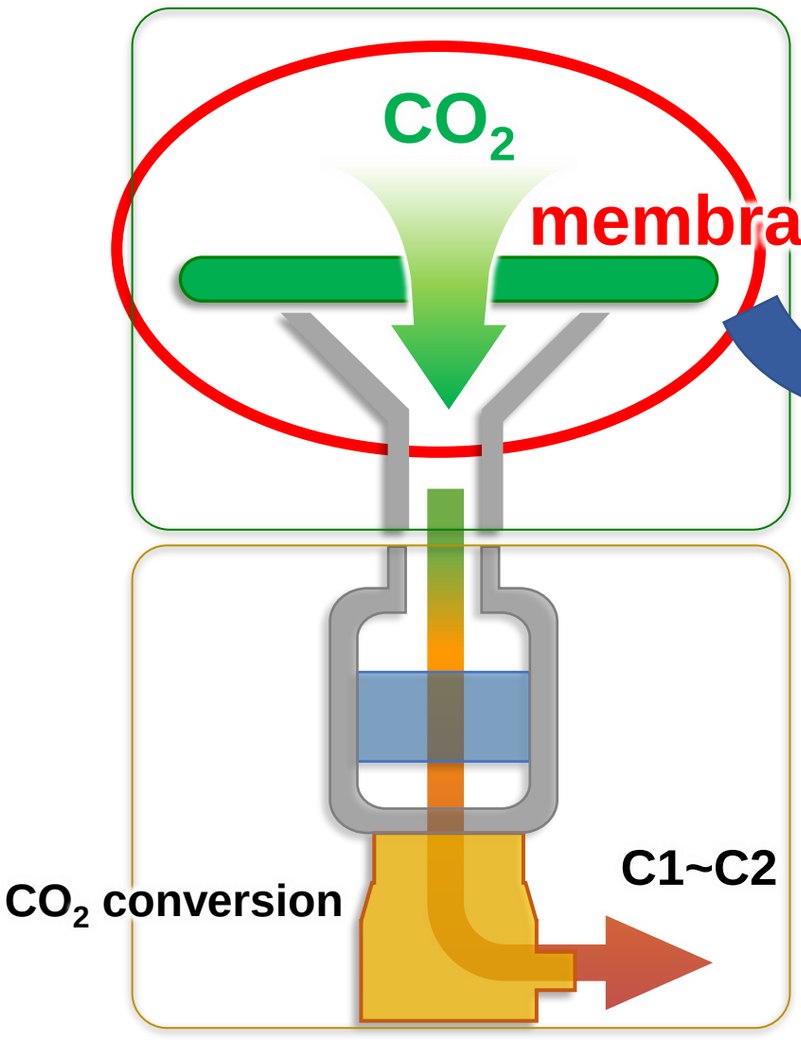
Development of Global CO_2 Recycling Technology Towards "Beyond-Zero" Emissions

[CO_2 capture research unit]

DAC-U



Development of CO_2 Separation nanomembrane Enabling DAC

CO_2 in air : 0.04%

×1000 upgrade

40%

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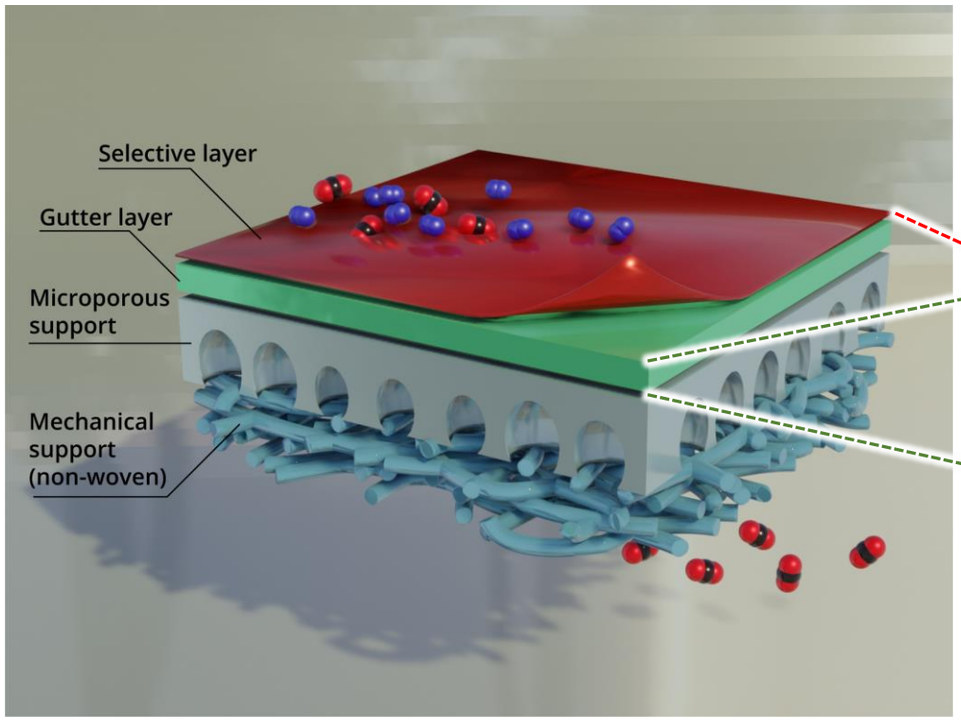
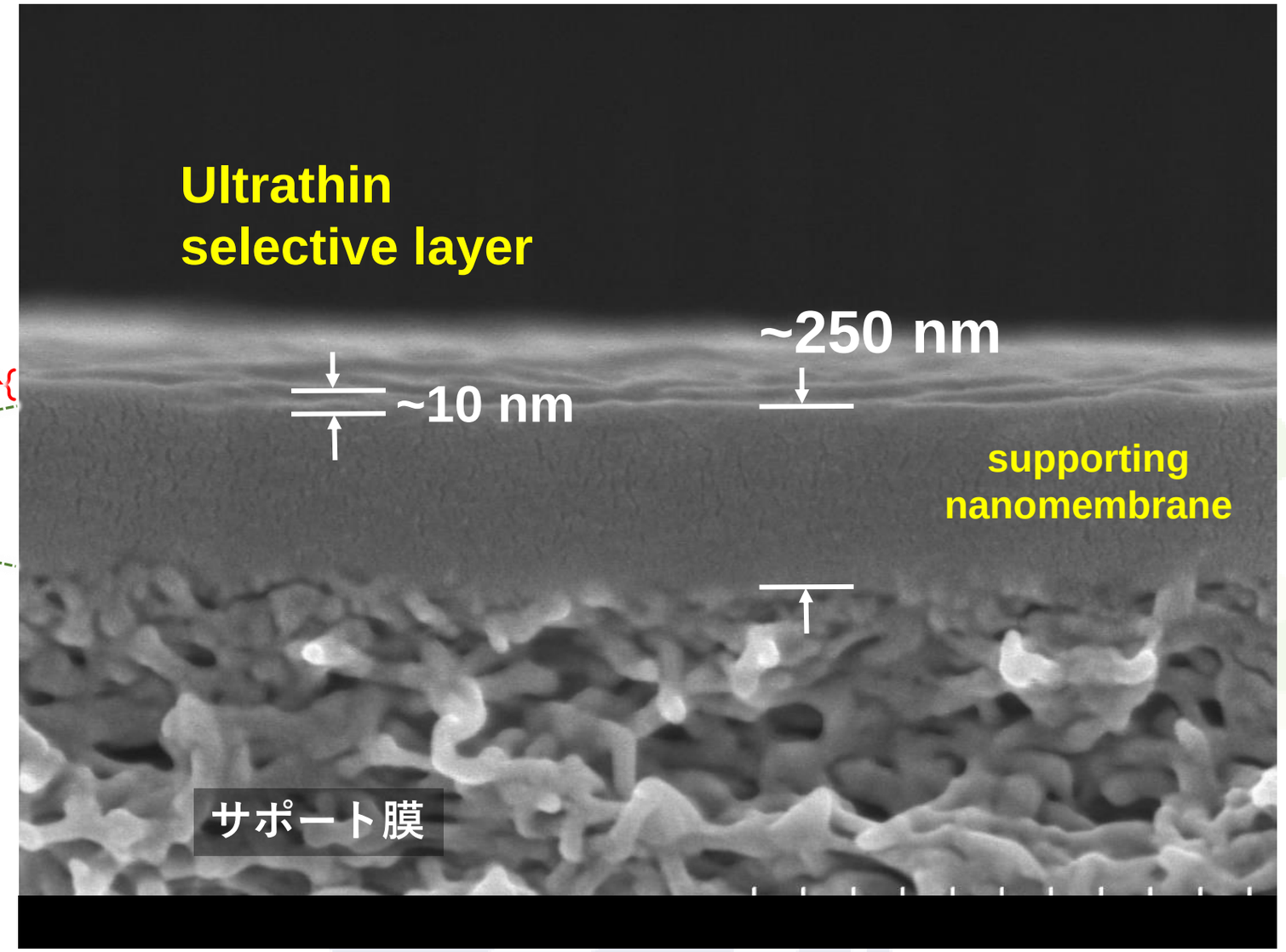
Kyushu Univ.
International Institute for Carbon Neutral Energy Research

PJ Institutes:
Kyushu Univ., Kumamoto Univ., Hokkaido Univ., Kagoshima Univ.,
Osaka Inst. Tech., Univ. Illinois at Urbana Champaign, NanoMembrane Tech. Inc.

Structure of high-performance CO_2 separation membranes

[2]





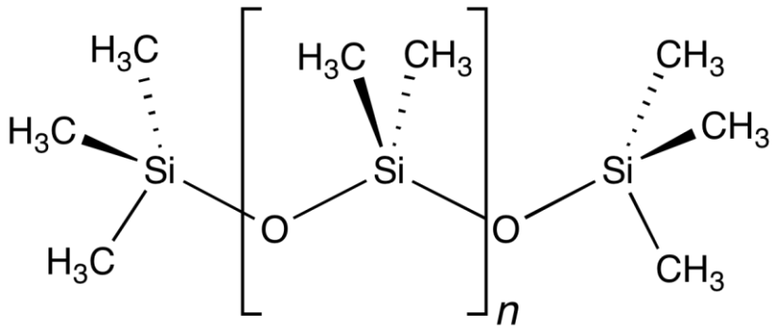
Selyanchyn O., Selyanchyn R., Fujikawa S. *ACS Appl. Mater. Interfaces,* 2020

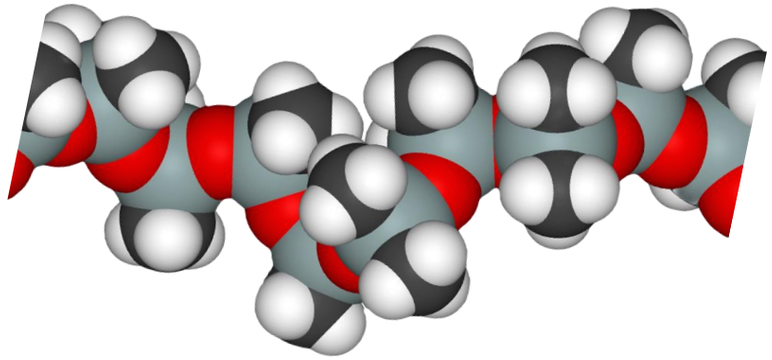
Material development based on silicone polymers

Structural Diversity of Silicone (Organosilicon Resins)

[3]

Polydimetylsiloxane (PDMS)





Inorganic polymers popularly used as a silicone oil, a silicone rubber.

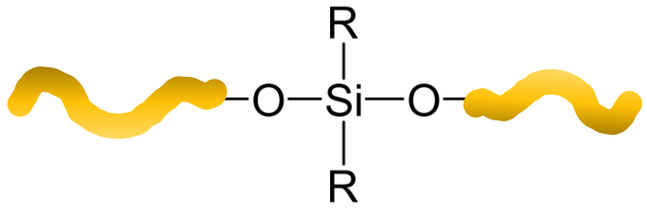
Highly Sustainable Materials

The 9 times reducing CO_2 emissions by the use of silicone polymers.

Global Silicones Council (GSC) report

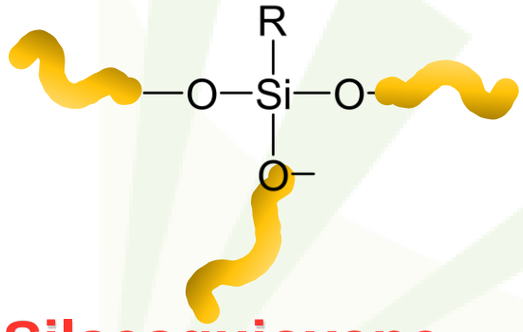
From liquid to Solid

Silicone oil
Linear chain structure



PDMS

Silicon glass
3D network structure



Silsesquioxane

Structural optimization for CO_2 separation

- Control of cross-linked structure
- Introduction of functional groups with high CO_2 affinity

- High CO_2 selectivity and permeability
- Toughness and flexibility that enables thin films

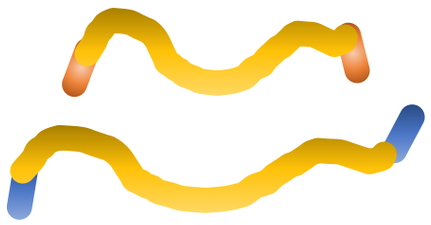
Elucidation of structural-functional correlation

Hierarchical control of the higher-order structures of cross-linked PDMS membranes

[4]

PDMS building blocks

End reactive PDMS



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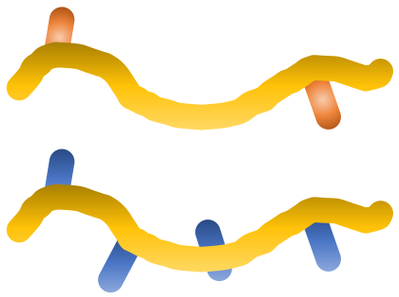
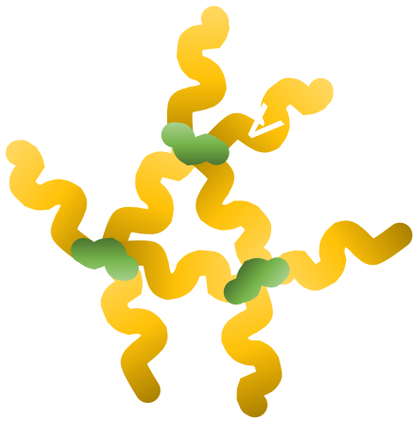
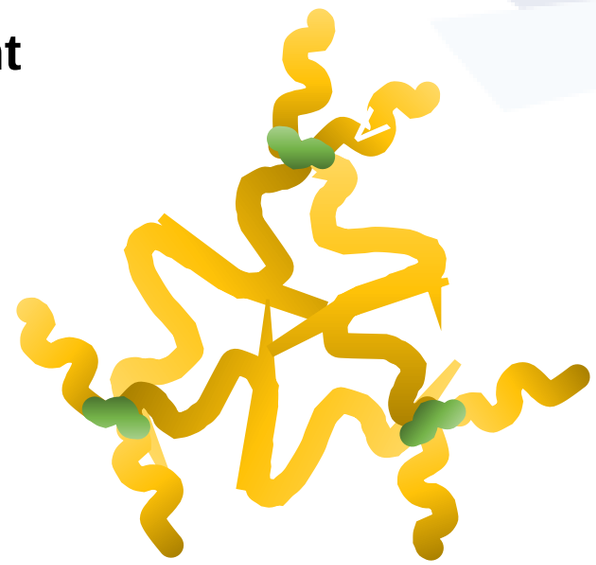
Side chain reactive PDMS
Multipoint cross-linking agent

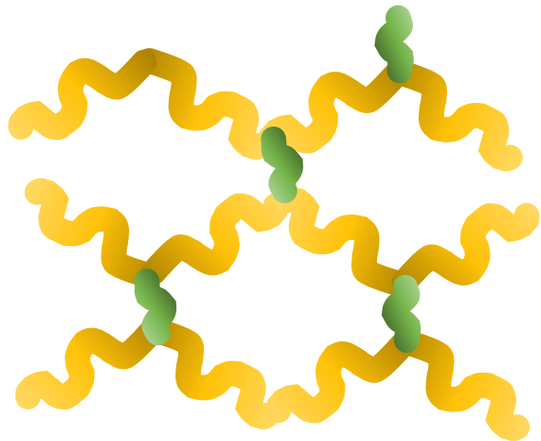


PDMS network polymers

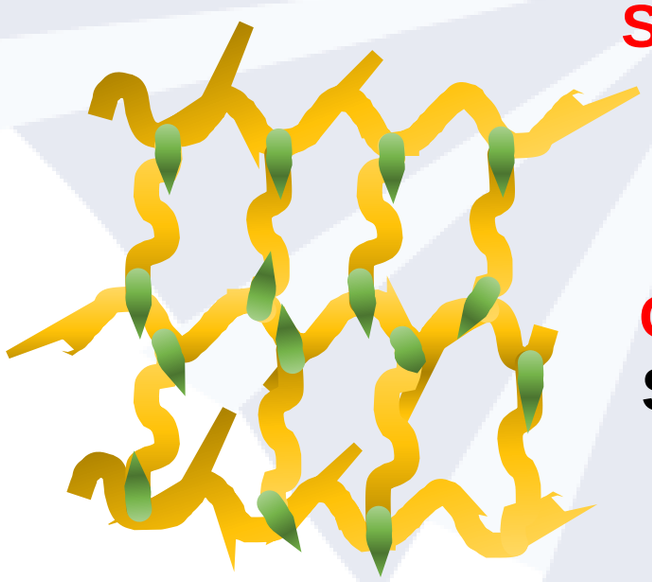


The distance between cross-linking points





Density of cross-linking points



Systematic Synthesis of Crosslinked Polymers
Structural Diversity

↓

Evaluation of CO_2 Selective Permeation

↓

Elucidation of Structural Correlation to CO_2 Selectivity

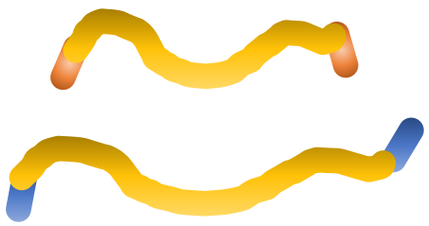
↓

Structural Optimization of CO_2-Selective Permeable Membranes

高CO_2透過性支持ナノ膜
架橋シリコーンにおける高次構造の階層的制御

Building Blocks

End reactive PDMS



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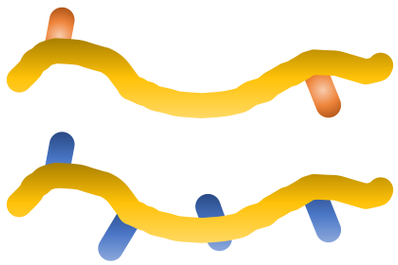
Side chain reactive PDMS
Multipoint cross-linking agents



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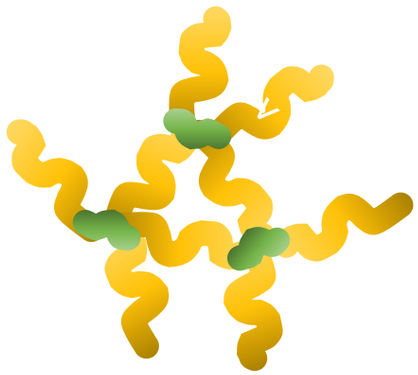
Substituent introduction agent

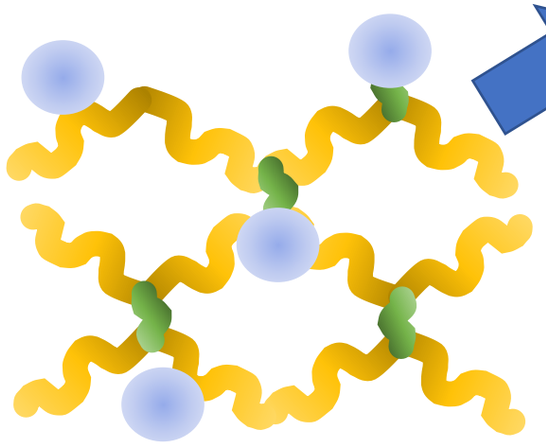
Library:
Newly synthesized polymers
20 or more

Crosslink in combinations

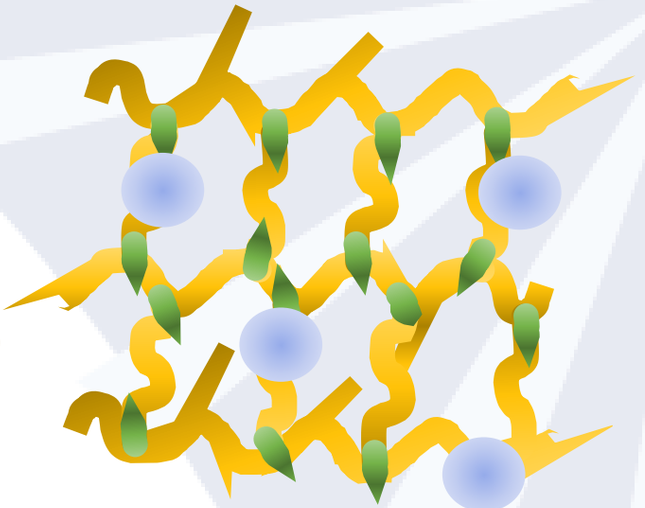
Systematic synthesis of network polymers



Control of cross-linking structures



Introduction of substituents with high CO2 affinity



Cooperation with **Structure Analysis unit**

Evaluation of **CO_2 selective permeation**

Screening & **Feedback to structural design**

50 or more
Cross-linked polymers and films has evaluated.


MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM